FIG. 3: AN IDEALIZED REPRESENTATION OF FIG. 1.

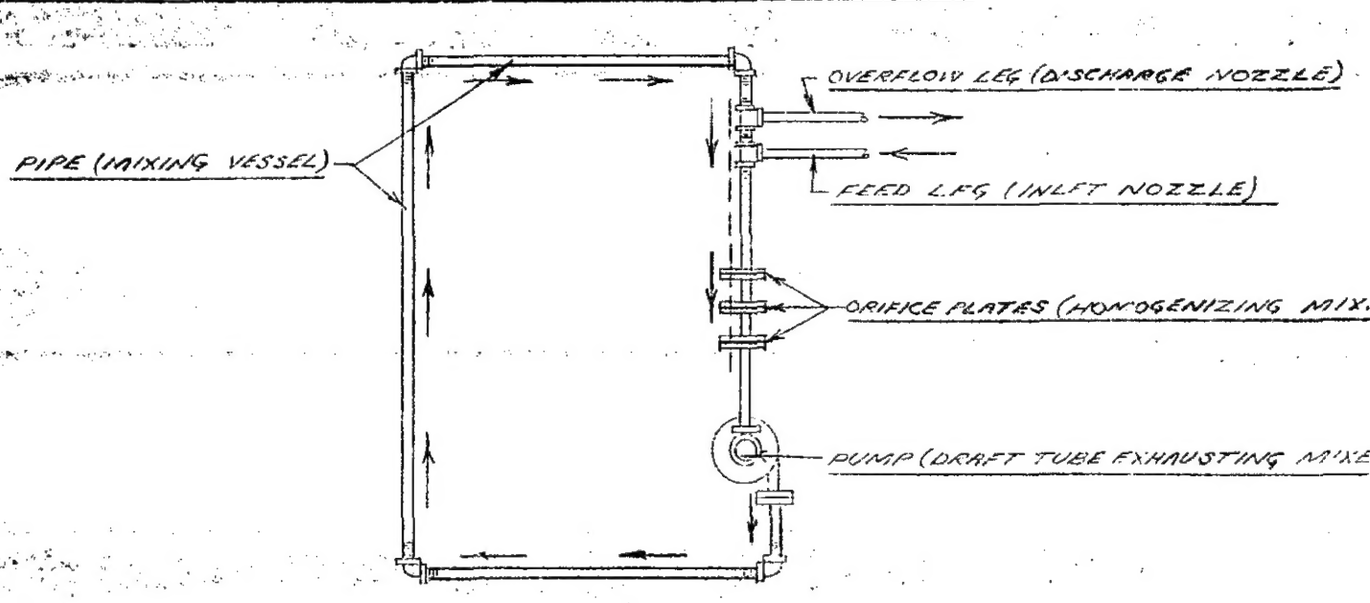
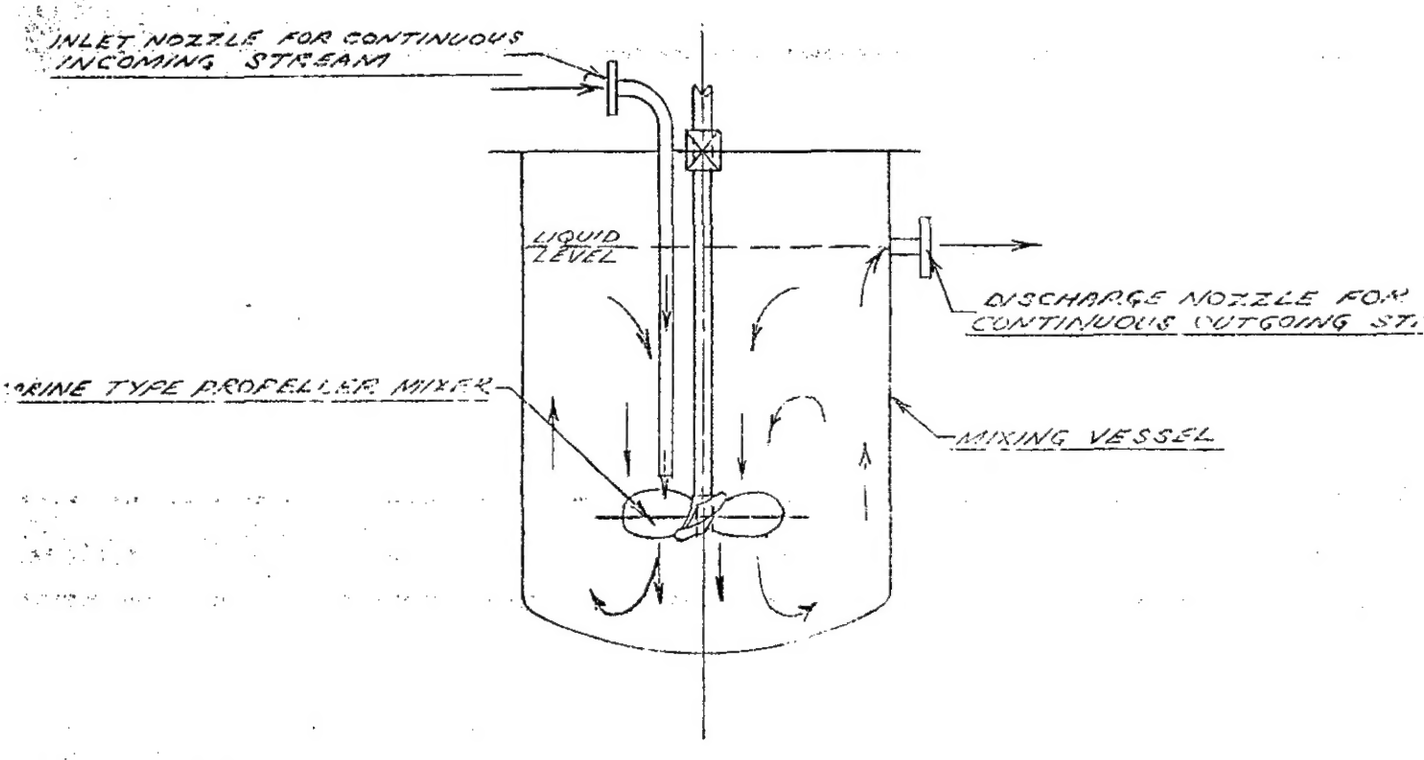
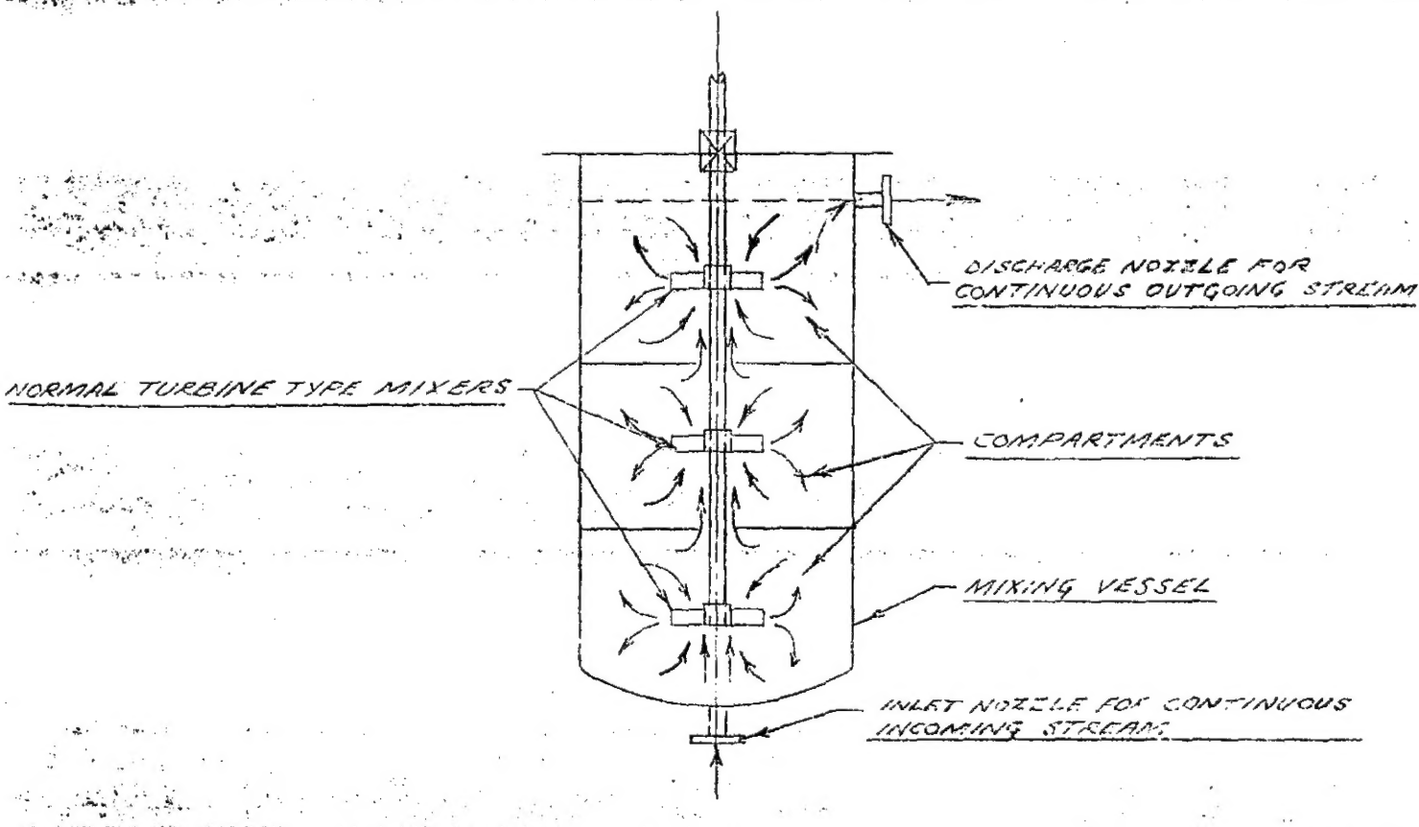


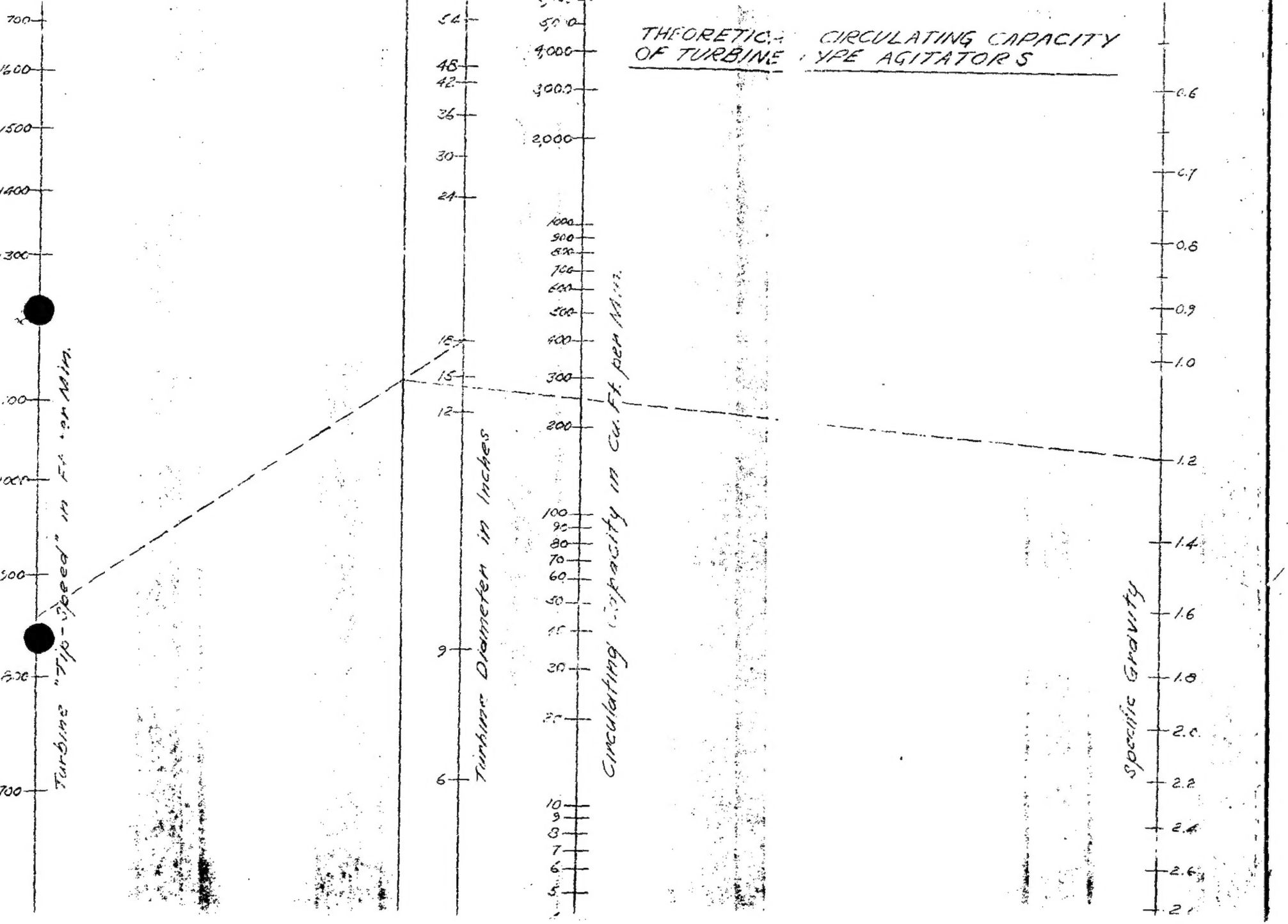
FIG. 4: CONTINUOUS MIXER WITHOUT DRAFT-TUBE

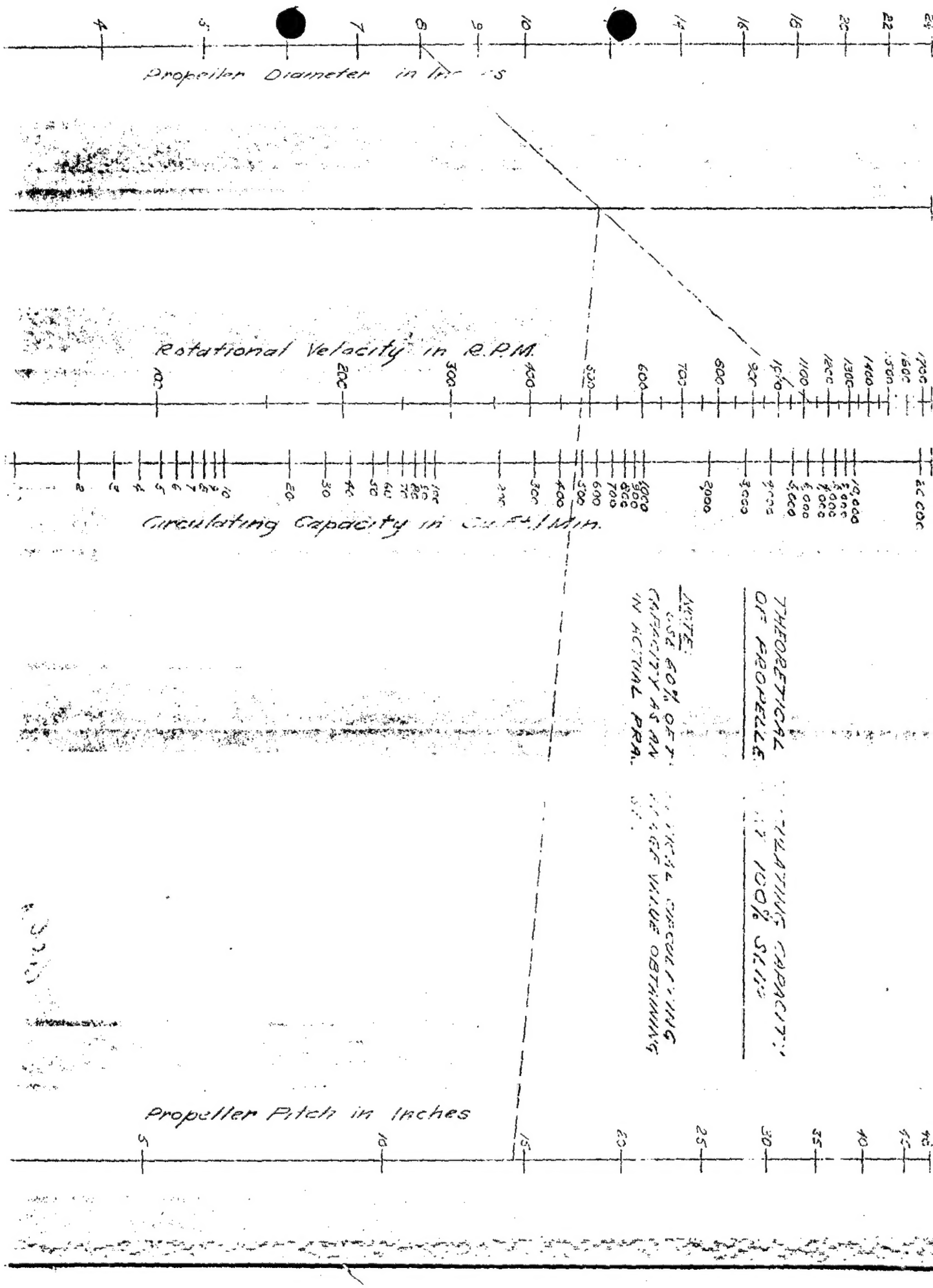


CHEMURGY DESIGN CORPORATION
GRAYBAR BUILDING
NEW YORK, N. Y.

FIG. 5: A "COMPARTMENTALIZED" CONTINUOUS COMBINER




THEORETICAL CIRCULATING CAPACITY OF TURBINE TYPE AGITATORS
Turbine "Tip-Speed" in Ft. per Min.
Turbine Diameter in Inches
Circulating Capacity in Cu. Ft. per Min.
Specific Gravity
700
1600
1500
1400
300
100
900
500
700
54
48
42
36
30
24
18
15
12
9
6
50,000
9,000
3000
2,000
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
0.6
0.7
0.8
0.9
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6


Propeller Diameter in Inches
Rotational Velocity in R.P.M.
Circulating Capacity in Cu. Ft./Min.
Propeller Pitch in Inches
THEORETICAL CIRCULATING CAPACITY OF PROPELLER.
ACTUAL CIRCULATING CAPACITY OF PROPELLER AS RUN IN ACTUAL PRACTICE.

SAC

6/26/50

SA RICHARD E. BRENNAN

HARRY GOLD, was.
ESPIONAGE - R

#4

65-4307-1-B-5 (29-17)

Reference is made to search memo dated June 8, 1950.

This material was shown to GOLD on June 21, 1950.

This exhibit consists of 33 typewritten sheets and 3 yellow sheets on which are drawings relating to Westinghouse aerosol container, Armstrong valve, and Pennsylvania engineer model aerosol dispenser.

GOLD stated that much of this material is duplication, and that it all refers to the aerosol matter on which BROTHMAN was working. GOLD stated that the typed sheets were undoubtedly typed by JENNIE RUZICKA, and added that the reason for so much duplication in this work was due to the fact that RUZICKA was a poor stenographer and poor typist, and had to retype things on many occasions.

GOLD stated that the yellow sheets referred to all contain drawings executed by BROTHMAN, and that the handprinting referring to these drawings is also by BROTHMAN.

GOLD said that he received this material sometime around May of 1943, and that it was given to him by BROTHMAN with the understanding that it would be turned over to the Soviet Union. GOLD said that the reason he did not turn it over to his Soviet contact was, as he has previously stated, that the Soviets had lost interest in work which was BROTHMAN's own design and invention.

GOLD stated that this was material which was dictated by BROTHMAN and him to RUZICKA in BROTHMAN's office.

1 Copy of 3 page article on Aerosol was introduced into evidence by The Government at Brothman's trial and is being maintained by USA, SDNY

RLB:cab
65-4307

SAC 6/8/50

SA WILLIAM H. NAYLOR

HARRY GOLD, was.
ESPIONAGE - R

RE: GOLD RESIDENCE SEARCH MATERIAL

Exhibit No. 65-4307-1-B-5 (29-17)

Reference memorandum, 6/6/50, Page 15.

Description:

Three copies of an eight page article on "General Methods of Aerosol Dispensing". One three page article on "Westinghouse Aerosol Containers". Two copies of a two page article on "Filling Density". One three page artical concerning Aerosol.

Three yellow sheets of paper containing drawings -- Figure 1 - Westinghouse Aerosol Container; Figure 2 - Armstrong Valve; Figure 5 - Pennsylvania Engineers Model Aerosol Dispenser, respectively.

Possible Leads:

No apparent leads other than material might be used if GOLD is questioned regarding his activities relating to Aerosol Dispensing.

WHN:ams
65-4307

I. Introduction--General Method of Aerosol Dispensing

The general method of aerosol dispensing consists of

1. the dissolving of solids and/or liquids in low boiling point liquids; or the dissolving of the solids and/or the liquids in a material which is miscible with a low boiling point liquid
2. the formation of a spray of the result of the solution has a function of the vapor pressure exerted by the low boiling point component

In brief, the general theory of the aerosol dispensing method involves the use of it less (1) component in a mixture whose vapor pressure is of such an order so that the mixture is propelled from any container in which it is stored under its own vapor pressure. This method of dispensing results in a fine spray which leads to the dispersion of the dissolved materials in the form of a finally divided mist. Most of the work done in this connection is that of Dr. Lyle D. Goodhue of the Department of Agriculture, Beltsville Station, Maryland.

Dr. Goodhue's early work included the use of various of the low molecular weight hydrocarbons such as propane, butane, and many of the low molecular weight chlorinated hydrocarbons, as the high vapor pressure component of various aerosol mixtures. Dr Goodhue found that low molecular weight saturated hydrocarbons presented hazards from stand-point of explosions due to the formation of mixtures with air on release of the mixture; and he also found most of the chlorinated hydrocarbons to be unsatisfactory from the stand-point of toxicity. His early work is concerned with the killing of household pests, although he has recently extended this work to many of the

uses, as for example in the dispersion of killing agents in plant pest control.

Dr. Goodhue's work of recent is centered around the use of Freon 12 as the high vapor pressure propellant medium. His use of Freon 12, in his recent work, was based upon the fact that Freon is neither toxic, nor does it form explosives mixtures with air. While the aerosol method of dispensing has been used in the dispensing of plant hormones and plant pest controls only on an experimental basis, the use of a mixture consisting of 2% pyrethrum, 8% sesame oil, and 90% Freon 12 has been widely applied in the Armed Forces in dealing with the mosquito problem in those sections of the world where malaria is common. This mixture, packed in containers which shall be described below, been used by men under combat conditions to throw off mosquitos, has been used to free barracks and pyramidal tents of mosquitos and other small insects, and has been used to fumigate transport planes returning from foreign regions to the United States. In this connection, please note exhibit (1), which include Navy specifications for the aerosol mixture as described above, as well as exhibits 2,3, and 4, containing other pertinent data.

II. Survey of Contents of this Report

It is our intention to treat with the following subjects in connection with aerosol dispensing method, in the following sequence:

1. the design of aerosol dispenser valves and the design of aerosol dispensing containers.
2. the design of equipment for the compounding of the pyrethrum-sesame-in Freon mixture

exit from the 1/32 inch diameter hold, shown in figure (2). The use of a fine thread between the valve stand and the valve body together with the close fit between the two threads develope a seal against leakage along the entire length of the threads and out from the top valve body.

NOTES

1-- Filling Density

Is defined by Navy specifications to mean the ratio of the actual fill-weight to the weight of water which the entire container will hold. This is required to be held to mixture 1.05, for the container in figure (2). The reason why filling density is a criterion aspect of the specifications with the fact that Freon has a very large coating vision of volumentric expansion with temperature. Since the projective use of the container in tropical areas, into storage of the container during shipment, might possibly bring it into high temperature zones. Fill-weight which would exceed the criteria density sighted above, would, in the case of the of the container shone in figure (2), project the possibility that the liquid would expand to a volumn approaching to and exceeding the volumn of the container, thus placing container at such a time under perished pressure in view of the virtual incompressiblty of pressure.

2--

The basis of this statement is that in every case the increment in pressure during the gas chargeing pressure would be uniform. By the gas laws, his automatic means the injection of an identical mo-weight of gas each time.

3--

There is no disputing that a temperature charge is of a necessity involved. We have chosen to neglect this element in the analysis firstly because it established

the most vapor conditions towards this method of controlling the method of film state because the temperature drop would be insignificant. We believe our contention in that the temperature drop would be insignificant on the following facts, a--that the quantity of material left behind when the standpipe is uncovered, is in the order of 1 cc, thus hold the possible amount of Freon which will be vaporized to very modest dimensions; b--that in comparison with the ladent heat load involved with all of the Freon to evaporate the heat capacity of the container, is very large, will thus be seen that since the ladent heat load will be provided by both residual material and the container it-self. No appreciable change in the over all temperature of the system for the purpose of this analysis would prevail.

NOTES

1-- Filling Density

Is defined by Navy specifications to mean the ratio of the actual fill-weight to the weight of water which the entire container will hold. This is required to be held to mixture 1.05, for the container in figure (2). The reason why filling density is a criterion aspect of the specifications with the fact that Freon has a very large coating vision of volumentric expansion with temperature. Since the projective use of the container in tropical areas, into storage of the container during shipment, might possibly bring it into high temperature zones. Fill-weight which would exceed the criteria density sighted above, would, in the case of the of the container shone in figure (2), project the possibility that the liquid would expand to a volumn approaching to and exceeding the volumn of the container, thus placing container at such a time under perished pressure in view of the virtual incompressiblty of pressure.

2--

The basis of this statement is that in every case the increment in pressure during the gas chargeing pressure would be uniform. By the gas laws, his automatic means the injection of an identical mo-weight of gas each time.

3--

There is no disputing that a temperature charge is of a necessity involved. We have chosen to neglect this element in the analysis firstly because it established

the most vapor conditions towards this method of controlling the method of film s.ate because the temperature drop would be insignificant. We believe our contention in that the temperature drop would be insignificant on the following facts, a--that the quantity of material left behind when the standpipe is uncovered, is in the order of 1½cc, thus hold the possible amount of Freon which will be vaporized to very modest dimensions; b--that in comparison with the ladent heat load involved with all of the Freon to evaporate the heat capacity of the container, is very large,will thus be seen that since the ladent heat load will be provided by both residual material and the container it-self. No appreciable change in the over all temperature of the system for the purpose of this analysis would prevail.

In brief, the Westinghouse aerosols container, was based upon throwing it away after single usage, so far as the Army quartermaster is concerned. For reasons that we shall explore later, however, it will be observed that this constituted and unnecessary waste of material.

A method of puting the container into use consists of:--

1) invert the container so that the standpipe is opened to the vapor phase
2) holding the container in the position set forth in (1) wiggling the wire shown on figure (1) until the fuse joint is broken, there-by permiting the escape of Freon vapor from the container.
3) to start the spray, the container is again inverted, this time placing the standpipe open and in the liquid phase
4) when sufficient amounts of the spray has been used, the container is again inverted as in (1) and the cap shown in figure (1) is threaded on the nipple. All successive uses of the container until exhaustion of the container involve repition of steps 1,3, and 4. Approximately 7,000, 000 containers of this construction have already been provided to the Army. On an average, these have been proportioned in bad malarial areas, to the extent of six thousand containers per-division. To the best of the writers knowledge, approximately two million more containers are now on order with the Westinghouse company.

The United States Navy put the use of aerosols bombs into effect at a considerably later date than the Army. From the beginning the engineering division of the Navy comitted itself to a container which could be refilled in the field.

The second model container, still based on the throw away principal, was manufactured by the Armstrong Engineering Company for the Army. This model involves a two piece container, after the style of the Westinghouse container, although somewhat different in shape. Its principal difference from the Westinghouse model dispensor, lay in that it involved a formal valve device, as will be seen in figure 2. A puncturable soft metal seal is laid down on a shoulder of the valve body and is heat fused to the valve body. This is done prior to the filling of the container, the container being filled through an opening on the opposite end from the valve. The opening through which filling is done later becomes point of placement of a fuse metal plug. The valve body consists of an interm thread member having two shoulders:-- one against which a soft metal seal is binded; and (2) one against which the neoprene gasket is driven by the action of the valve stand. The valve stand consists of a knurled head screw provided with a shoulder against which the neoprene gasket acts and provided with a curnicle end. The conicle end provides and means where-by the soft metal seal is punctured when the container is put into use. The shoulder on the valve stand provided the companion surface to the required in development to the neoprene gasket when the sealing usages of the container is required. The neoprene gasket is of smaller diameter than the threads, thus permitting the valve stand to introduce into the valve body. To put the container into successive usages for any single charge, the valve stand is screwed away from the valve body shoulder against which the neoprene gasket is compressed, there-for permitting the flow of the aerosol fluid up to the upper parts of the vlave body and its

3. The design of both manual and automatic types of aerosol container filling machines as used in the main filling plants.

4. the design of equipment for the refilling of the containers under field conditions, then lastly the review of the prospects for this development

III. Aerosols

When the use of the pyrethrum-sesame-freon mixture was adopted by the Armed Forces, two definite schools of thought regarding the use of dispensing valves sprang up within the United States Army. One school moved largely by the desire to institute production of aerosol containers at the earliest possible moment and also moved by the thought that the collecting and returning of the aerosol containers to field filling depots, would constitute a cumbersome quartermaster problem, adopted a container that did not involve a formal valve device. Instead, the early one-pound containers distributed to Army Personnel was of the construction shown in figure (1).

I. Introduction--General Method of Aerosol Dispensing:-

The general method of aerosol dispensing consists of

1. the dissolving of solids and/or liquids in low boiling point liquids; or the dissolving of the solids and/or the liquids in a material which is miscible with a low boiling point liquid
2. the formation of a spray as the result of the expulsion of the liquid phase through a small orifice under the influence of the vapor pressure exerted by the low boiling point component

In brief, the general theory of the aerosol dispensing method involves the use of a low boiling point component in a mixture in such proportions that vapor pressure over the mixture is of such an order as to permit the propelling of the mixture from any container in which it is stored. This method of dispensing, when performed with a properly designed dispenser, results in a fine spray which leads to the dispersion of the dissolved materials in the form of a finely divided mist. Most of the work done in this connection is that of Dr. Lyle D. Goodhue of the Department of Agriculture, Beltsville Station, Maryland.

Dr. Goodhue's early work included the use of various of the molecular weight hydrocarbons such as propane, butane, and many of the low molecular weight chlorinated hydrocarbons, as the high vapor pressure compon-

ents of vario[illegible] aerosol mixtures. Dr. G[illegible]hue found that the low molecular weight saturated hydrocarbons (such as propane, butane, etc.) presented hazards from standpoint of explosions due to the formations of explosives mixtures of the hydrocarbon with air on release of the mixture; and he also found most of the low boiling point chlorinated hydrocarbons to be unsatisfactory from the standpoint of toxicity.* His early work is concerned with the killing of household pests, although he has recently extended this work to many other uses, as for example in the dispersion of killing agents in plant pest control.

Dr. Goodhue's work of recent is centered around the use of Freon 12 as the high vapor pressure propellant medium. His use of Freon 12, in his recent work, was based upon the fact that freon is neither toxic, nor does it form explosive mixtures with air. While the aerosol method of dispensing has been used in the dispensing of plant hormones and plant pest controls only on an experimental basis, the use of a mixture consisting of 2% pyrethrum, 8% sesame oil, and 90% Freon 12 has been widely applied in the Armed Forces in dealing with the mosquito problem in those sections of the world where malaria is common. This mixture, packed in containers which shall be described below has been used by men under combat conditions to "throw off" mosquitos, has been used to free barracks and pyramidal tents of mosquitos and other small insects, and has been used to fumigate trans-

*Especially where indoor use of the aerosol mixture is projected.

port planes returning from foreign regions to the United States. In this connection, please note exhibit (1), which include Navy specifications for the aerosol mixture as described above, as well as exhibits 2,3, and 4, containing other pertinent data.

II. Survey of Contents of this Report:-

It is our intention to treat with the following subjects in connection with aerosol dispensing method, in the following sequence:

1. the design of aerosol dispenser valves and the design of aerosol dispensing containers
2. the design of equipment for the compounding of the pyrethrum-sesame Freon mixture
3. the design of both manual and automatic types of aerosol container filling machines as used in the main filling plants
4. the design of equipment for the refilling of the containers under field conditions
5. lastly, the review of the prospects for this development

III. Aerosols

When the use of the pyrethrum-sesame-Freon mixture was adopted by the Armed Forces, two definite schools of thought regarding the use of dispensing valves sprang up within the United States Army. One school, moved largely by the desire to institute production of aerosol

containers at the earliest possible moment and also moved by the thought that the collecting and returning of the aerosol containers to field-filling depots would constitute a cumbersome quartermaster problem, adopted a container that did not involve a formal valve device. Instead, the early one-pound containers distributed to Army Personnel was of the construction shown in figure (1).

In brief, the Westinghouse aerosol container (Fig. 1) was based upon a single useage, so far as the Army quartermaster is concerned.* For reasons that we shall explore later, however, it will be observed that this constituted and unnecessary waste of material.

The method of putting the container (shown in Fig. 1) into use consists of:-

1) inverting the container so that the standpipe is opened to the vapor phase
2) holding the container in the position set forth in (1), wiggling the wire shown (Fig.1) until the fused joint is broken, joining the sealing wire to the base of the discharge nipple there-by permitting the escape of Freon vapor from the container
3) to start the spray, the container is again inverted, this time placing the standpipe open and in the liquid phase
4) when sufficient amounts of the spray has been used, the container is again inverted as in (1) and the

* See Page of the "

cap shown in Fig. 1 is threaded on the nipple. All successive uses of the container until exhaustion of the container involve repetion of steps 1,3, and 4. Approximately 7,000,000 containers of this construction have already been provided to the Army. On an average, these have been proportioned in bad malarial areas to the extent of six thousand containers per division. To the best of the writer's knowledge, approximately twelve million more containers are now on order with the Westinghouse company.

A second model of container, still based on the "throw-away principal", is manufactured by the Armstrong Engineering Company for the Army. This model involves a two piece container, after the style of the Westinghouse container, although somewhat different in shape. Its principal difference from the Westinghouse model dispenser lay in that it involved a formal valve device, as will be seen in Fig. 2. A puncturable soft metal seal is laid down on a shoulder of the valve body and is heat-fused to the valve body. This is done prior to the filling to the container, the container being filled through an opening in the opposite end from the valve. The opening through which filling is done later becomes point of placement of a fusible metal plug. The vlave body consists of an internally threaded member having two shoulders:--one against which a soft metal seal is binded; and one against which the neoprene

gasket is driven by the action of the valve stem. The valve stem consists of a knurled head screw provided with a shoulder against which the neoprene gasket acts and provided with a conical end. The conical end provides a means, whereby the soft metal seal is punctured when the container is put into use. The shoulder on the valve stem provides the companion surface to the valve body shoulder against which the neoprene gasket is driven when the sealing of the container's contents is required. The neoprene gasket is of smaller diameter than the threads, thus permitting the valve stem to introduce the gasket into the valve body. To put the container into successive useage for any single charge , the valve stem is screwed away from the valve body shoulder against which the neoprene gasket is compressed, thereby permitting the flow of the aerosol fluid up to the upper parts of the valve body and its exit from the 1/32" diameter hole, shown in Fig. 2. The use of a fine thread between the valve stem and the valve body and a close fit between the two threads develops a seal against leakage along the entire length of the threads and out from the top valve body, since byso doing the friction drop required of the fluid if leaking is to occur exceeds the friction drop required for expulsion of the fluid through the 1/32" diameter hole mentioned above.

The United States Navy put the use of aerosol bombs into effect at a considerably later date than the Army. From the beginning the engineering division of the Navy comitted itself to a container which could be refilled in the field.

In line with this policy the Navy adopted two models of containers:-

1) a model, as per enclosed Figs. 3 and 4 - manufactured by the Bridgeport Brass Company
2) a model as per Fig. 5 - manufactured by the Pennsylvania Engineering Company.

The type of dispenser manufactured by Bridgeport Brass Company is fully described in Figs. 3 and 4, of which Fig. 3 is a 10:1 scale drawing of the valve device, and Fig. 4, is a full size drawing of the assembled container.

Bothe of these models and devices operate on the principal the needle valve, Bridgeport model being modified to permit discharge of the material up through the center of the valve stem. In neither case does the valve stem mate with a ground seat. Instead advantage is taken in the difference in hardness between the valve and the valve body materials; and of the mechanical advantage offered by the aformentioned threads is important to the development at the line of contact (between the conicla portion of the valve stem and the valve body "corner" of) a compressive stress exceeding the elastic limit for the valve body material. Thus, there is accomplished a plastic deformation of the valve body at the line of contact with the stem, which deformation becomes the formed seat for the valve stem. In the case of the Bridgeport valve, an ultimate value for the closing torque of approximately 11 inch-lbs. is sufficient to

secure a tight joint between the valve stem and the valve body. A certain amount of grinding action between the valve stem on the valve body at the point of contact is developed due to the difference in between the contacted surfaces, tends to refine the seat with repeated use of the valve. This general type of valve device has been eminently successful in use and is now being adopted standard for all Army and Navy contracts.

I. Introduction--General Method of Aerosol Dispensing:-

The general method of aerosol dispensing consists of

1. the dissolving of solids and/or liquids in low boiling point liquids; or the dissolving of the solids and/or the liquids in a material which is miscible with a low boiling point liquid
2. the formation of a spray as the result of the expulsion of the liquid phase through a small orifice under the influence of the vapor pressure exerted by the low boiling point component

In brief, the general theory of the aerosol dispensing method involves the use of a low boiling point component in a mixture in such proportions that vapor pressure over the mixture is of such an order as to permit the propelling of the mixture from any container in which it is stored. This method of dispensing, when performed with a properly designed dispenser, results in a fine spray which leads to the dispersion of the dissolved materials in the form of a finely divided mist. Most of the work done in this connection is that of Dr. Lyle D. Goodhue of the Department of Agriculture, Beltsville Station, Maryland.

Dr. Goodhue's early work included the use of various of the molecular weight hydrocarbons such as propane, butane, and many of the low molecular weight chlorinated hydrocarbons, as the high vapor pressure compon-

ents of various aerosol mixtures. Dr. Goodhue found that the low molecular weight saturated hydrocarbons (such as propane, butane, etc.) presented hazards from standpoint of explosions due to the formation of explosives mixtures of the hydrocarbon with air on release of the mixture; and he also found most of the low boiling point chlorinated hydrocarbons to be unsatisfactory from the standpoint of toxicity. His early work is concerned with the killing of household pests, although he has recently extended this work to many other uses, as for example in the dispersion of killing agents in plant pest control.

Dr. Goodhue's work of recent is centered around the use of Freon 12 as the high vapor pressure propellant medium. His use of Freon 12, in his recent work, was based upon the fact that freon is neither toxic, nor does it form explosive mixtures with air. While the aerosol method of dispensing has been used in the dispensing of plant hormones and plant pest controls only on an experimental basis, the use of a mixture consisting of 2% pyrethrum, 8% sesame oil, and 90% Freon 12 has been widely applied in the Armed Forces in dealing with the mosquito problem in those sections of the world where malaria is common. This mixture, packed in containers which shall be described below has been used by men under combat conditions to "throw off" mosquitos, has been used to free barracks and pyramidal tents of mosquitos and other small insects, and has been used to fumigate trans-

*Especially where indoor use of the aerosol mixture is projected.

port planes returning from foreign regions to the United States. In this connection, please note exhibit (1), which include Navy specifications for the aerosol mixture as described above, as well as exhibits 2,3, and 4, containing other pertinent data.

II. Survey of Contents of this Report:-

It is our intention to treat with the following subjects in connection with aerosol dispensing method, in the following sequence:

1. the design of aerosol dispenser valves and the design of aerosol dispensing containers
2. the design of equipment for the compounding of the pyrethrum-sesame-freon mixture
3. the design of both manual and automatic types of aerosol container filling machines as used in the main filling plants
4. the design of equipment for the refilling of the containers under field conditions
5. lastly, the review of the prospects for this development

III. Aerosols

When the use of the pyrethrum-sesame-freon mixture was adopted by the Armed Forces, two definite schools of thought regarding the use of dispensing valves sprang up within the United States Army. One school, moved largely by the desire to institute production of aerosol

containers at the earliest possible moment and also moved by the thought that the collecting and returning of the aerosol containers to field-filling depots would constitute a cumbersome quartermaster problem, adopted a container that did not involve a formal valve device. Instead, the early one-pound containers distributed to Army Personnel was of the construction shown in figure (1).

In brief, the Westinghouse aerosol container (Fig. 1) was based upon a single useage, so far as the Army quartermaster is concerned.* For reasons that we shall explore later, however, it will be observed that this constituted and unnecessary waste of material.

The method of putting the container (shown in Fig. 1) into use consists of:-

1) inverting the container so that the standpipe is opened to the vapor phase
2) holding the container in the position set forth in (1), wiggling the wire shown (Fig.1) until the fused joint is broken, joining the sealing wire to the base of the discharge nipple there-by permitting the escape of Freon vapor from the container
3) to start the spray, the container is again inverted, this time placing the standpipe open and in the liquid phase
4) when sufficient amounts of the spray has been used, the container is again inverted as in (1) and the

* See Page of the "

cap shown in Fig. 1 is threaded on the nipple. All successive uses of the container until exhaustion of the container involve repetion of steps 1,3, and 4. Approximately 7,000,000 containers of this construction have already been provided to the Army. On an average, these have been proportioned in bad malarial areas to the extent of six thousand containers per division. To the best of the writer's knowledge, approximately twelve million more containers are now on order with the Westinghouse company.

A second model of container, still based on the "throw-away principal", is manufactured by the Armstrong Engineering Company for the Army. This model involves a two piece container, after the style of the Westinghouse container, although somewhat different in shape. Its principal difference from the Westinghouse model dispenser lay in that it involved a formal valve device, as will be seen in Fig. 2. A puncturable soft metal seal is laid down on a shoulder of the valve body and is heat-fused to the valve body. This is done prior to the filling to the container, the container being filled through an opening in the opposite end from the valve. The opening through which filling is done later becomes point of placement of a fusible metal plug. The vlave body consists of an internally threaded member having two shoulders:--one against which a soft metal seal is binded; and one against which the neoprene

gasket is driven by the action of the valve stem. The valve stem consists of a knurled head screw provided with a shoulder against which the neoprene gasket acts and provided with a conical end. The conical end provides a means, whereby the soft metal seal is punctured when the container is put into use. The shoulder on the valve stem provides the companion surface to the valve body shoulder against which the neoprene gasket is driven when the sealing of the container's contents is required. The neoprene gasket is of smaller diameter than the threads, thus permitting the valve stem to introduce the gasket into the valve body. To put the container into successive useage for any single charge , the valve stem is screwed away from the valve body shoulder against which the neoprene gasket is compressed, thereby permitting the flow of the aerosol fluid up to the upper parts of the valve body and its emit from the 1/32" diameter hole, shown in Fig. 2. The use of a fine thread between the valve stem and the valve body and a close fit between the two threads develops a seal against leakage along the entire length of the threads and out from the top valve body, since byso doing the friction drop required of the fluid if leaking is to occur exceeds the friction drop required for expulsion of the fluid through the 1/32" diameter hole mentioned above.

The United States Navy put the use of aerosol bombs into effect at a considerably later date than the Army. From the beginning the engineering division of the Navy comitted itself to a container which could be refilled in the field.

In line with this policy the Navy adopted two models of containers:-

1) a model, as per enclosed Figs. 3 and 4 - manufactured by the Bridgeport Brass Company
2) a model as per Fig. 5 - manufactured by the Pennsylvania Engineering Company.

The type of dispenser manufactured by Bridgeport Brass Company is fully described in Figs. 3 and 4, of which Fig. 3 is a 10:1 scale drawing of the valve device, and Fig. 4, is a full size drawing of the assembled container.

Bothe of these models and devices operate on the principal the needle valve, Bridgeport model being modified to permit discharge of the material up through the center of the valve stem. In neither case does the valve stem mate with a ground seat. Instead advantage is taken in the difference in hardness between the valve and the valve body materials; and of the mechanical advantage offered by the aformentioned threads is important to the development at the line of contact (between the conicla portion of the valve stem and the valve body "corner" of) a compressive stress exceeding the elastic limit for the valve body material. Thus, there is accomplished a plastic deformation of the valve body at the line of contact with the stem, which deformation becomes the formed seat for the valve stem. In the case of the Bridgeport valve, an ultimate value for the closing torque of approximately 11 inch-lbs. is sufficient to

secure a tight joint between the valve stem and the valve body. A certain amount of grinding action between the valve stem on the valve body at the point of contact is developed due to the difference in between the contacted surfaces, tends to refine the seat with repeated use of the valve. This general type of valve device has been eminently successful in use and is now being adopted standard for all Army and Navy contracts.

FIG. 1 — WESTINGHOUSE AEROSOL CONTAINER (1# MONT)

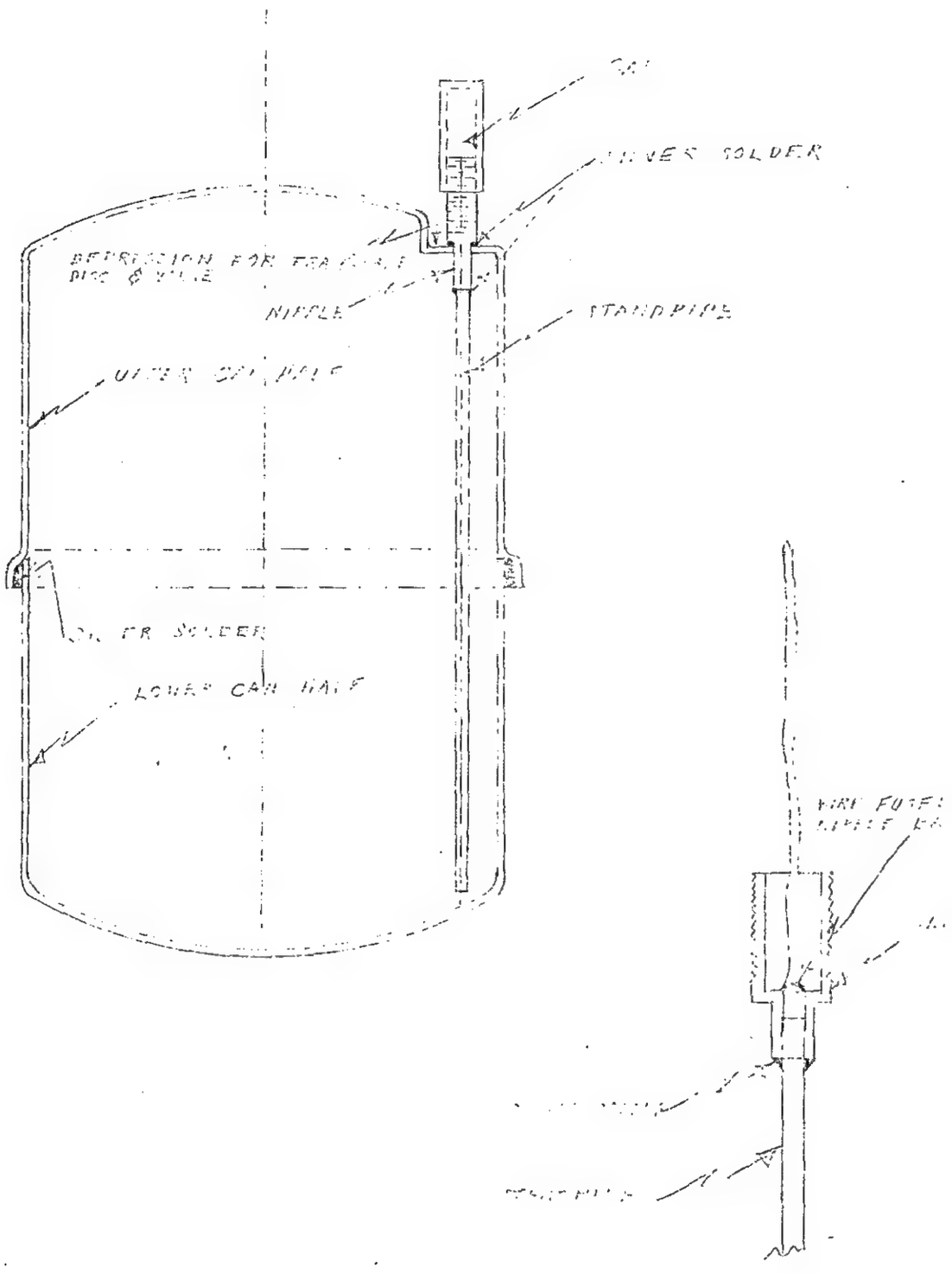


FIG. 8 — ELASTRON VALVE

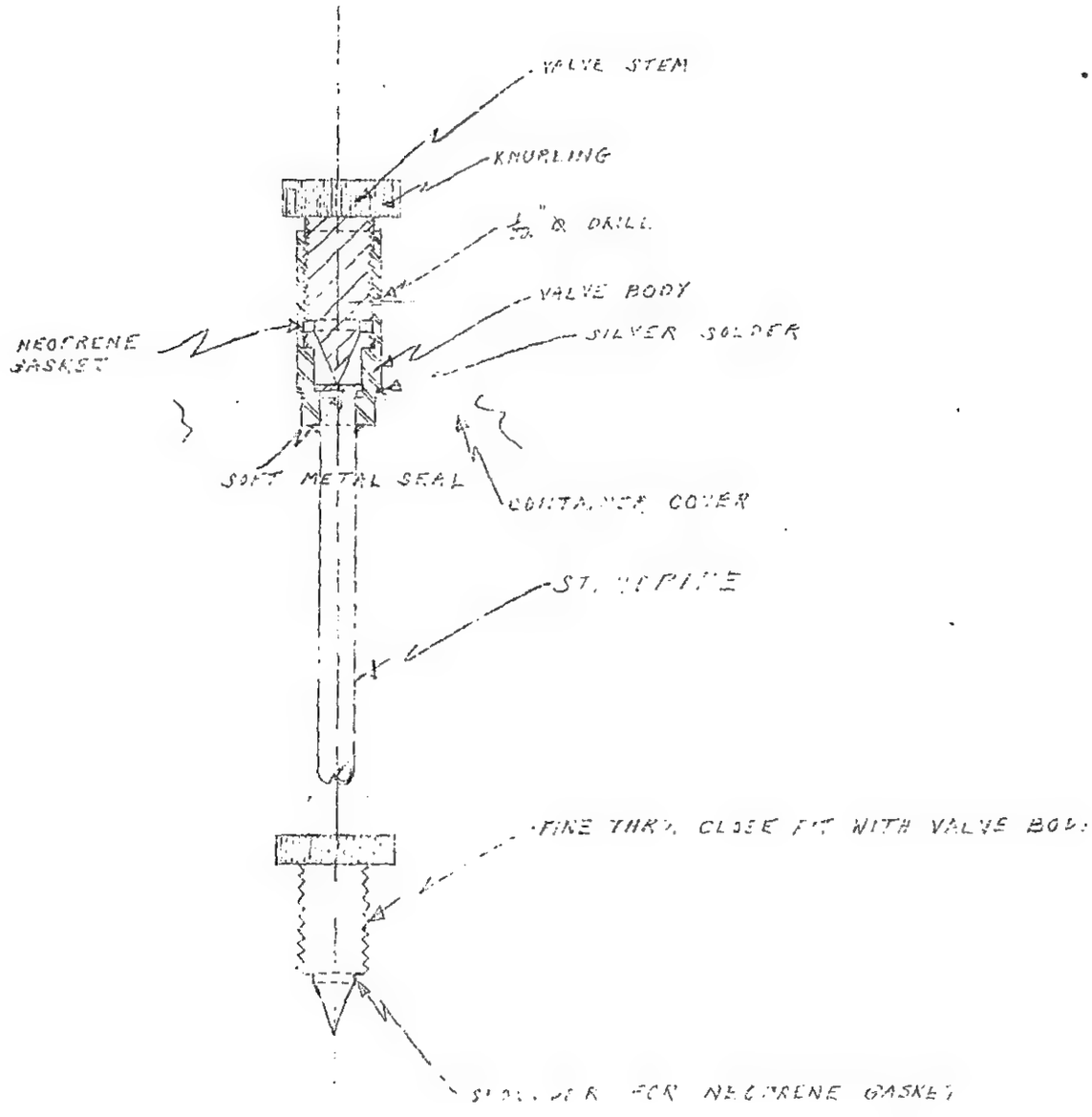
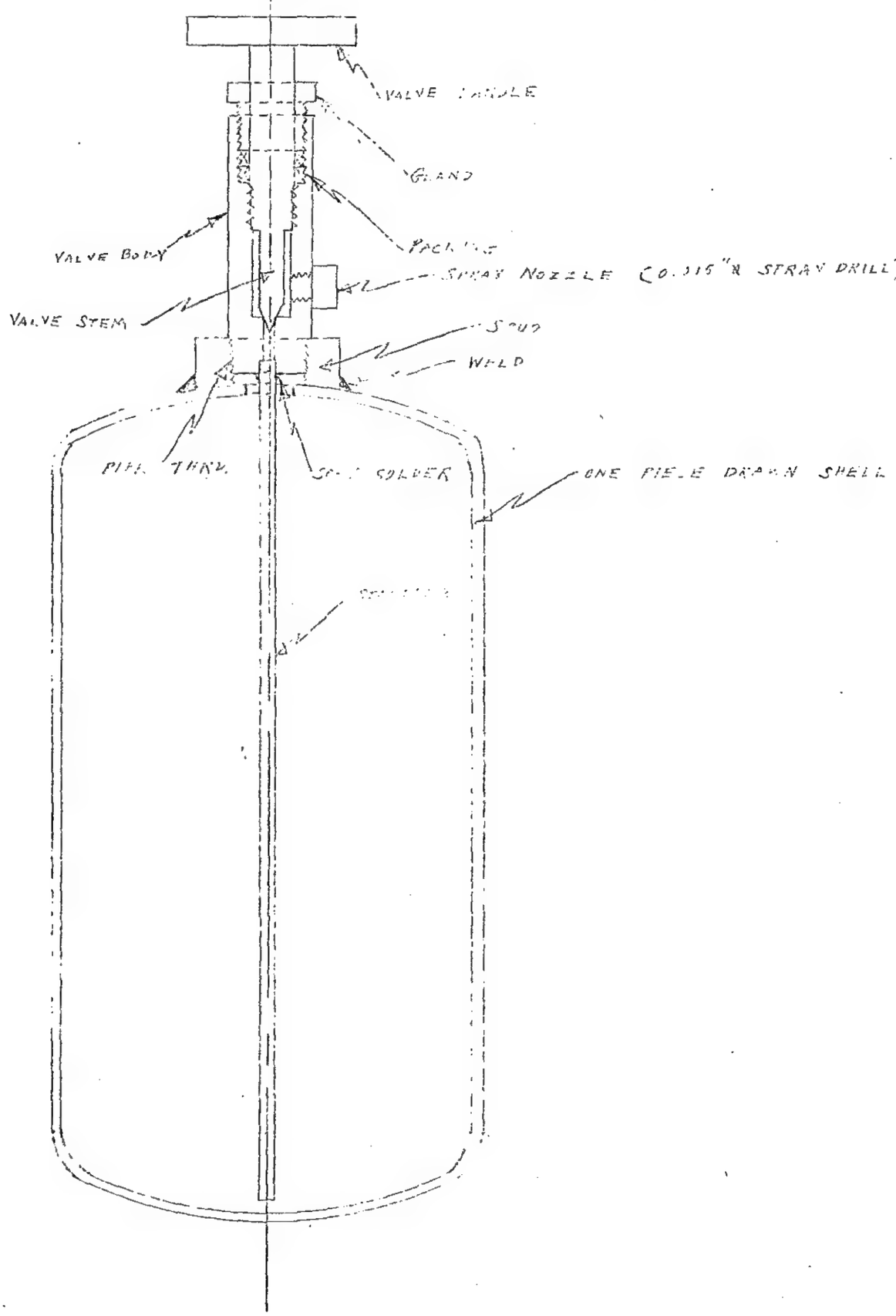


FIG. 5 — PENNSYLVANIA [illegible] AEROSOL DISPENSER



SAC

June 24, 1950

SA T. SCOTT MILLER, JR.

HARRY GOLD, was.,
ESPIONAGE - R

Exhibit 65-4307-1B-12 (4) - Folder #6

MATERIAL FOUND IN WOODEN BOX
IN BASEMENT OF GOLD'S HOME

The above exhibit, consisting of a folder holding several blue prints, was exhibited to GOLD on June 22, 1950. They are identified as follows:

(1) A print of the CHEMURGY DESIGN CORPORATION, #102-F, entitled "Chemurgy Diagrammatic Flow Sheet for Nickel Catalyst Pellets and Vehicle Protected Nickel Catalyst," dated September 2., 1942. This was drawn by ARTHUR P. WEBER.

(2) A print of the Chemurgy Plan #105-B2, dated August 20, 1942, entitled "Assembly Details for Dry Reducer - The RUFERT CHEMICAL COMPANY, Seymour, Connecticut." This was drawn by R. K. T., and checked and approved by ARTHUR P. WEBER.

(3) A print of the Chemurgy Plan #105-B1, Dated August 19, 1942, entitled "Intermediate Guide Bearing for Dry Reducer - THE RUFERT CHEMICAL COMPANY, Seymour, Connecticut." This was drawn by R. K. T. and checked and approved by WEBER.

(4) A print of the Chemurgy Plan #105-C1, dated August 17, 1942, entitled "Dry Reducer Section - THE RUFERT CHEMICAL COMPANY, Seymour, Connecticut." This was drawnby WEBER and checked by BROTHMAN and approved by WEBER.

(5) A print of the Chemurgy Plan #105-D1, dated August 29, 1941, entitled "Dry Reducer - THE RUFERT CHEMICAL COMPANY, Seymour, Connecticut." This was drawn by WEBER, checked by BROTHMAN and approved by WEBER.

GOLD advised that the above material all referred to the RUFERT Plant which worked on a nickel catalyst, and for which plant BROTHMAN did work while at Chemurgy. GOLD advised that BROTHMAN gave all of this material to him for sub-

TJT:as
65-4307

Items 1 through 5 above were put in evidence by The Government at Brothman's trial and are being maintained by WFO only.

mission to the Soviet Union but GOLD did not turn this material over to SAK because SAK had told GOLD that the Soviets were not interested in anything which was BROTHMAN's own work or design. GOLD added that at this time SAK was trying to get GOLD to persuade BROTHMAN to go to work for one of the big rubber manufacturing companies.

SAC

June 23, 1950

SA T. SCOTT MILLER, JR.

HARRY GOLD, was.,
ESPIONAGE - R

#7

Exhibit 65-4307-17-12 (2) - Envelope #2

MANILA ENVELOPE FOUND IN WOODEN BOX
IN BASEMENT OF GOLD'S HOME

The above exhibit, consisting of handwritten notes on pages numbered Five through sixteen, inclusive, on letterhead stationery of GOLDMINE CHEMICAL CORPORATION, was shown to GOLD on June 22, 1950. GOLD stated that this was in his handwriting and that it must have been copied from material that FRUCHMAN gave GOLD on mixing equipment. GOLD said that this may have been material that he himself had helped FRUCHMAN on, but he is sure the material was later turned over by FRUCHMAN to him in the form of a complete report and then GOLD turned the report over to SAX about August of 1942.

It is noted that there are numerous blank pages of the above letterhead contained in this folder.

TJM:ras
65-4307

[illegible]

$p + q = 1$ [illegible]

a. the probability [illegible] of the [illegible] would be $= p^4$

b. the probability [illegible] of [illegible] would be $= (p^5 - p^4 + 3p^3 q)\, p$

$= (1 - p + 3q)\, p^4$

$= 4 q p^4$

c. the probability [illegible] of [illegible] 6 [illegible]

would be $= (p^5 - p^4 + 3p^3 q - 4p^4 q + 6p^3 q^2)\, p$

$= (1 - p + 3q - 4pq + 6q^2)\, p^4$

$= 10 q^2 p^4$

d. the probability [illegible] of [illegible] 7 [illegible]

would be $= (p^5 - p^4 + 3p^3 q - 4p^4 q - 6p^3 q^2 - 10q^2 p^4 + 10 p^2 q^3)\, p$

$= (1 - p + 3q - 4pq + 6q^2 - 10q^2 p + 10q^3)$

$= 20 q^3 p^4$

[illegible], the [illegible] coefficients of $(a + b)^n$ [illegible] for [illegible] 6

1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1

6. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

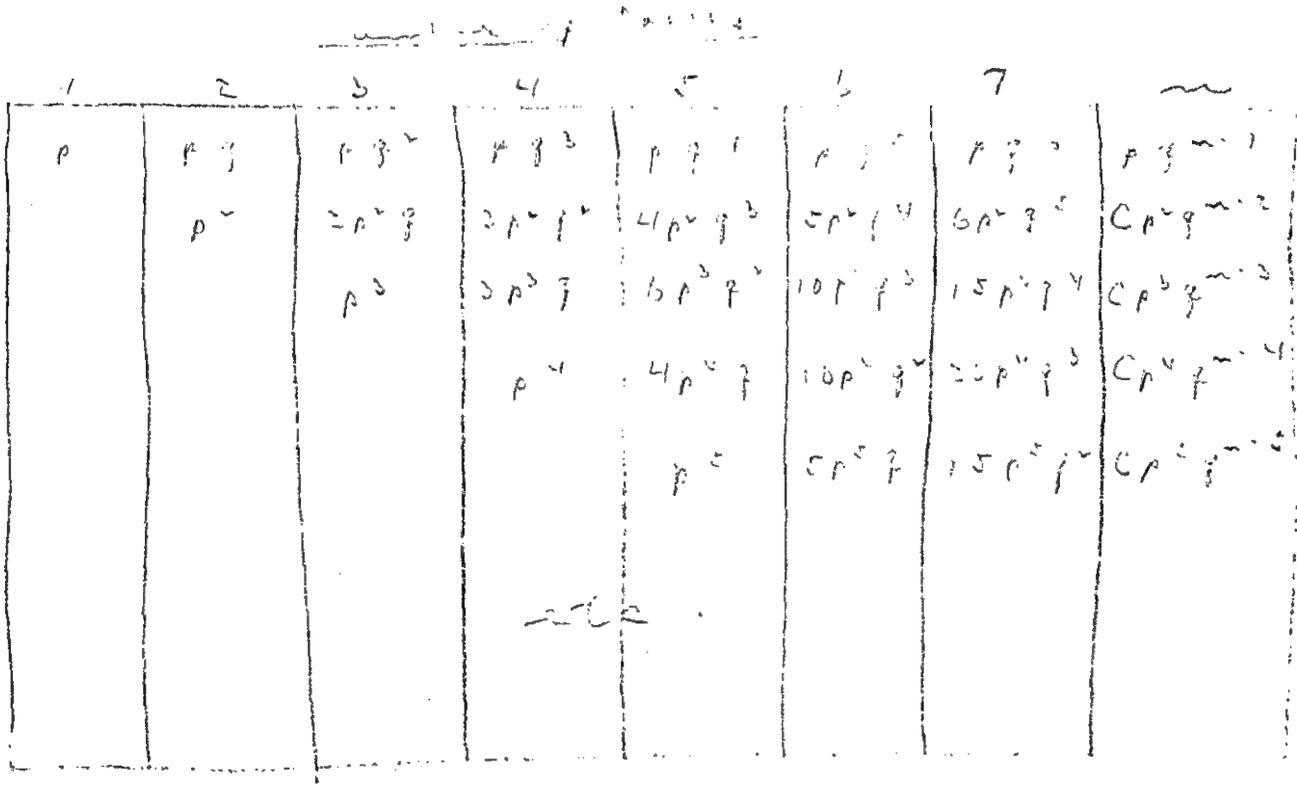


Fig. 3.

[illegible]

[illegible]

$$w\ (n,\ w)$$

[illegible]

$$\sum_{w=1}^{\infty} w\ (n,\ w) = 1$$

[illegible] ... that all reactions [illegible] ... following [illegible] $x = f(\lambda t)$, where x [illegible] of a material [illegible] dissolved or [illegible] while k is a constant [illegible] and t is the time which has elapsed since "compounding". Thus in

a) Considering the integrated form of the solution velocity equation for dissolving rates and solubility in the particle

$$t = \frac{2.3}{k_1 A} \log \frac{C_s}{C_s - C_t} \qquad (1)$$

where t is in hours, k_1 is the solution velocity constant, A is the area of the particle, C_s is the saturation concentration of the solute in the solvent, and C_t is the [illegible] concentration of [illegible] at time t.

(1) may be written as

$$\lambda t = \log_e \frac{C_s}{C_s - C_t} \qquad (2)$$

where

$$\lambda_1^{-1} = \frac{1}{k_1 A}$$

or

$$\frac{C_s}{C_s - C_t} = e^{\lambda t} \qquad (3)$$

b) Considering the integrated form of the first order reaction velocity equation

$$t = \frac{2.3}{k_2} \log \frac{a}{a - x} \qquad (4)$$

where t is as above and k_2 is the first order reaction velocity constant, a is the initial concentration of the reacting material, and x is the

... corresponding to the time interval t

(4) may be written as

$$\lambda_2 t = \log \frac{a}{a-x} \qquad (5)$$

where

$$\lambda_2^{-1} = \frac{1}{k_2}$$

(5) may be written as

$$e^{\lambda_2 t} = \left(\frac{a}{a-x} \right) \qquad (6)$$

c) Considering the integral form of the velocity equation for a second order reaction

$$t = \frac{2.3}{k_3 (a-b)} \log \frac{b(a-x)}{a(b-x)} \qquad (7)$$

where k_3 = [illegible] velocity constant, a = initial concentration of one reactant, b = initial concentration of the other reactant, x = decrease in concentration of the reactant in time interval t.

(7) may be written as

$$\lambda_3 t = \log \frac{b(a-x)}{a(b-x)} \qquad (8)$$

where

$$\lambda_3^{-1} = \frac{1}{k_3 (a-b)}$$

(8) may be written as

$$e^{\lambda_3 t} = \frac{b(a-x)}{a(b-x)} \qquad (9)$$

d) Considering the integral form of the [illegible] equation for a third order reaction

$$t = \frac{2.3}{k_4} \left[\frac{1}{a-c} \log \frac{a}{a-x} + \frac{1}{a-b} \log \frac{b}{b-x} + \frac{1}{b-c} \log \ldots \right.$$

[illegible]

[illegible] of the [illegible] k = [illegible]; $a' = (a+1)$; $b' = (b-c)$ and $c' = (c+$

(12) [illegible]

$$t = \frac{2.3}{k_{1,2}} \log \left[\left(\frac{a}{a-x} \right)^{\frac{1}{a'c'}} \left(\frac{b}{b-x} \right)^{\frac{1}{a'b'}} \left(\frac{c}{c-x} \right)^{\frac{1}{b'c'}} \right]$$

(11) [illegible]

$$\lambda_4 t = \log \left[\left(\frac{a}{a-x} \right)^{\frac{1}{a'c'}} \left(\frac{b}{b-x} \right)^{\frac{1}{a'b'}} \left(\frac{c}{c-x} \right)^{\frac{1}{b'c'}} \right]$$

[illegible]

$$\lambda_4^{-1} = \frac{1}{k_{1,2}}$$

or (12) [illegible]

$$e^{\lambda_4 t} = \left[\left(\frac{a}{a-x} \right)^{\frac{1}{a'c'}} \left(\frac{b}{b-c} \right)^{\frac{1}{b'a'}} \left(\frac{c}{c-x} \right)^{\frac{1}{a'c'}} \right] \quad (1$$

[illegible] of each of the [illegible] above [illegible]:

$$(\quad) = e^{\lambda t} \quad (14)$$

where $(\quad)$ [illegible] and [illegible] (3), (5), (9), [illegible] (3)

[illegible]

$$\sum_{m=k} [illegible] (k, m)\, e^{\lambda m t} \quad (15)$$

where [illegible] the [illegible] [illegible]

[illegible] to [illegible] [illegible] (k, m); [illegible]

[illegible] (15)

(18) [illegible]

(19) $u(k+1, n+1) = u(k, n) p + u(k, n+1) r$

[illegible] consider the power series

$$\phi(x, y) = \sum_{k=1}^{\infty} \sum_{n=0}^{\infty} u(k, n) x^{k} y^{n}$$

[illegible] the [illegible] $u(k, n)$, and then determine the [illegible] of $\phi(x, y)$

[illegible] (18) [illegible] the [illegible]

(20) $$\sum_{k=1}^{\infty} \sum_{n=0}^{\infty} u(k+1, n+1) = \sum_{k=1}^{\infty} \sum_{n=0}^{\infty} u(k+1, n) q + \sum_{k=1}^{\infty} \sum_{n=0}^{\infty} u(k, n$$

[illegible] (18) [illegible]

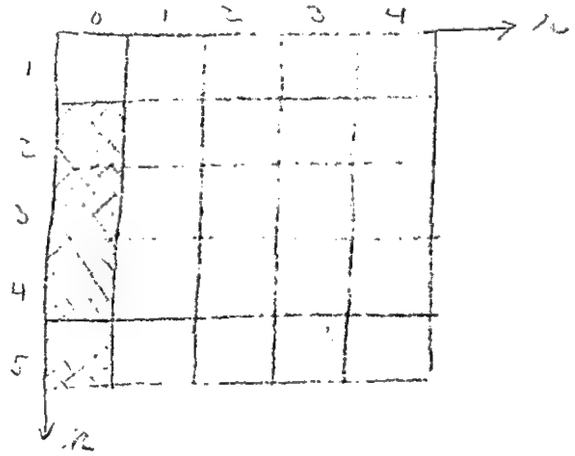
$$(x^{k+1} y^{n+1}) :-$$

(21) $$\sum_{k=1}^{\infty} \sum_{n=0}^{\infty} u(k+1, n+1) x^{k+1} y^{n+1} = \sum_{k=1}^{\infty} \sum_{n=0}^{\infty} q\, u(k+1, n) x^{k+1} y$$

$$+ \sum_{k=1}^{\infty} \sum_{n=0}^{\infty} p\, u(k, n+1) x^{k+1} y$$

8. [illegible] k [illegible] ∞, and [illegible] 0 to ∞ — [illegible] Expressions (16) and (17) are valid only for

$$k \geq 1$$
$$n \geq 0$$


0
1
2
3
4
5

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

(illegible)

SAC

June 25, 1950

SA T. SCOTT MILLER, JR.

HARRY GOLD, was.,
ESPIONAGE - R

Exhibit 65-4307-1B-12 (2) - Envelope #1

MANILA ENVELOPE FOUND IN WOODEN BOX
IN BASEMENT OF GOLD'S HOME

The above exhibit was shown to GOLD on June 22, 1950.

Contained in this envelope were several blank income tax returns (federal) for the year of 1942. GOLD said that these were just extra forms that he had obtained and never used.

Also contained in this envelope was a shipping order, dated January 14, 1943, from the ENTERPRISE MILL SOAP WORKS to M. E. DOUGHERTY at the PENNSYLVANIA ALCOHOL CORPORATION. One pound of sample grease remover was consigned to DOUGHERTY. GOLD stated that this invoice must have inadvertently been mixed in with GOLD's papers.

Also contained in this envelope were white sheets of paper, numbered 1 through 4 and 17 through 25. GOLD identified this as being in his handwriting and advised it goes with the material contained in Exhibit 1B-12 (2) - Envelope #2. He said it concerned mixing equipment and mixers and that like Envelope #2, the material had been given to him by BROTHMAN for submission to the Soviet Union.

Also contained in this envelope were one white sheet of paper and one yellow sheet of paper, containing what appears to be equations. GOLD stated this is not in his handwriting. He said it might be in BROTHMAN's handwriting and he does not know to what it refers.

TSM:as
65-4307

The material mentioned in paragraphs 3 and above was introduced into evidence by the government at Brotheman's trial and is being maintained by the USA, SDNY

CONTRACT T[illegible] AND CONDITIONS

Sec. 1. (a) The carrier or party in possession of any of the property [illegible] shall be liable as at common law for any loss thereof or damage thereto, except as [illegible]

[illegible]

Sec. 2. (a) No carrier is bound to transport said property by any particular train or vessel, or in time for any particular market or otherwise than with reasonable dispatch. [illegible]

[illegible]

...ific Domestic Straight Bill of Lading, adopted by Carriers in Official, Southern, Western and Illinois Classification territories, Mar. 15, 1922, as amended Aug. 1, 1930, and June 15, 1941.)

THIS SHIPPING ORDER MUST BE LEGIBLY FILLED IN, IN INK, IN INDELIBLE PENCIL, OR IN CARBON, AND RETAINED BY THE AGENT.

Shipper's No. 00021

COMPANY

Agent's No.

RECEIVE, subject to the classifications and tariffs in effect on the date of the issue of this shipping order,

Philadelphia, Pa., Jan. 1st, 194- From **ENTERPRISE MILL SOAP WORKS**

...e property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said company (the word ...ompany being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its own road or its own water line, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the conditions not prohibited by law, whether printed or written, herein contained, including the conditions on back hereof, which are hereby agreed to by the shipper and accepted for himself and his assigns.

(Mail or street address of consignee—For purposes of notification only.)

Consigned to ... ... Dougherty, Penna. Alcohol Corp.

Destination 1067 N. Delaware Ave. Phila.

State of

County of

Route

Delivering Carrier

Car Initial

Car No.

Description of Articles, Special Marks and Exceptions	*WEIGHT (Sub. to Cor.)	Class or Rate	Ck. Col.	No. Pkgs.	Description of Articles, Special Marks and Exceptions	*WEIGHT (Sub. to Cor.)	Class or Rate	Ck. Col.
Cleaning Compound					Bbl.			
Bags					Drums			
1 pound sample grease remover								

Drums Returned | Carboys Returned

...the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's or shipper's weight."

NOTE—Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding ... per ...

Subject to Section 7 of conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

(Signature of consignor.)

If charges are to be prepaid, write or stamp here, "To be Prepaid."

Received $ ... to apply in prepayment of the charges on the property described hereon.

Agent or Cashier.

Per ...

(The signature here acknowledges only the amount prepaid.)

Charges advanced: $

ENTERPRISE MILL SOAP WORKS, Shipper, Per ...

AGENT MUST DETACH AND RETAIN THIS SHIPPING ORDER AND MUST SIGN THE ORIGINAL BILL OF LADING

Permanent post-office address of shipper: 2229 N. 12th St., PHILADELPHIA, PA.

...NTED

UARCO BUSINESS SYSTEMS ©

FORM 1040A
TREASURY DEPARTMENT
INTERNAL REVENUE SERVICE

OPTIONAL

UNITED STATES INDIVIDUAL INCOME TAX RETURN

CALENDAR YEAR
1942

THIS RETURN MAY BE FILED INSTEAD OF FORM 1040 BY CITIZENS (OR RESIDENT ALIENS) REPORTING ON THE CASH BASIS IF GROSS INCOME IS NOT MORE THAN $3,000 AND IS ONLY FROM SALARY, WAGES, DIVIDENDS, INTEREST, AND ANNUITIES

Do not write in these spaces

Serial No. _____

Amount Paid, $ _____

(Cashier's Stamp)

PRINT NAME AND HOME OR RESIDENTIAL ADDRESS PLAINLY BELOW

_____
(Name) (Use given names of both husband and wife, if this is a joint return)

_____
(Street and number, or rural route)

_____
(Post office) (County) (State)

Occupation _____ Social Security number, if any _____

Name and address of employer _____

(If you had more than one employer, attach statement showing name and address and amount received from each)

Cash—Check—M. O.

DEPENDENTS ON JULY 1, 1942

List persons (other than husband or wife) *deriving their chief support from you* if they are under 18 years of age or if they are mentally or physically incapable of self-support

NAME OF DEPENDENT	RELATIONSHIP	IF 18 YEARS OF AGE OR OVER, GIVE REASON FOR LISTING

*GROSS INCOME LESS ALLOWANCE FOR DEPENDENTS

1. Salary, wages, and compensation for personal services	$	
2. Dividends, interest, and annuities		
3. Total	$	
4. Less: $385 for each dependent		
(If you are the head of a family (see definition under item 6 on other side) *only because of dependent(s) listed above*, $385 for each listed dependent *except* one.)		
5. INCOME SUBJECT TO TAX	$	

TAX

6. Tax on item 5 (from Column A, B, or C of table on other side)	$	

I/we declare, under the penalties of perjury, that this return has been examined by me/us, and, to the best of my/our knowledge and belief, is a true, correct, and complete return, made in good faith, for the taxable year stated, pursuant to the Internal Revenue Code and regulations issued under authority thereof; and that I/we had no income from sources other than stated hereon.

_____, 1943.
(Date)*

_____
(Signature)

_____
(Signature)
(If this return includes gross income of both husband and wife, it must be signed by both.)

Filing requirement.—An income tax return must be filed by single persons having a gross income (item 3 above) of $500 or more and married persons having a gross income either separately or combined of $1,200 or more.

**Military and naval personnel.*—Members of the military or naval forces of the United States below the grade of commissioned officer on December 31, 1942, should not include in gross income the first $250 if single on such date, or the first $300 if married or head of a family on such date, received as compensation for active service.

Returns of husband and wife.—Husband and wife may use this form as a joint return if they were living together on July 1, 1942, and if their combined gross income for the calendar year is not more than $3,000. A separate return may be made on this form if the gross income for the calendar year of the one filing the return is not more than $3,000, except that in the case of a husband and wife living together at any time during the calendar year separate returns may not be made on this form unless each elects to use this form.

Allowance for dependents.—Allowance of $385 for each dependent is applicable when this form is used. Where Form 1040 is used, the allowance for each dependent is $350.

Amended returns.—If a qualified taxpayer elects to use this form, amended return may not be made on Form 1040.

Filing of returns and payment of tax.—The return must be filed with the Collector of Internal Revenue for your district on or before March 15, 1943. The tax may be paid in equal quarterly installments commencing March 15, 1943. Pay tax, if any, to the Collector and if payment is made by check or money order, make payable to "Collector of Internal Revenue."

16—31231-1

INDICATE YOUR STATUS ON JULY 1, 1942, BY PLACING CHECK MARK (✓) IN THE APPLICABLE BLOCK (☐) BELOW

1. Single (and not head of family) on July 1, 1942..... ☐

2. Married and not living with husband or wife (and not head of family) on July 1, 1942..... ☐

IF YOU CHECKED No. 1 OR No. 2 ABOVE, FIND YOUR TAX IN COLUMN A

3. Married and living with husband or wife on July 1, 1942, but each filing separate returns on this form... ☐

IF YOU CHECKED No. 3 ABOVE, FIND YOUR TAX IN COLUMN B

4. Married and living with husband or wife on July 1, 1942, and spouse had no gross income for the entire year..... ☐

5. Married and living with husband or wife on July 1, 1942, and this return includes gross income of both husband and wife for the entire year..... ☐

6. Head of family (a single person or married person not living with husband or wife who exercises family control and supports closely connected dependent relative(s) in one household) on July 1, 1942..... ☐
(State number of such dependent relatives .....)

IF YOU CHECKED No. 4, 5, OR 6 ABOVE, FIND YOUR TAX IN COLUMN C

IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C	IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C	IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C
Over	But not over	Your tax is	Your tax is	Your tax is	Over	But not over	Your tax is	Your tax is	Your tax is	Over	But not over	Your tax is	Your tax is	Your tax is
$0	$525	$0	$0	$0	$1,350	$1,375	$141	$122	$10	$2,175	$2,200	$283	$264	$150
525	550	1	0	0	1,375	1,400	145	126	14	2,200	2,225	288	269	155
550	575	4	0	0	1,400	1,425	149	130	17	2,225	2,250	292	273	159
575	600	7	0	0	1,425	1,450	154	135	21	2,250	2,275	296	277	163
600	625	11	0	0	1,450	1,475	158	139	25	2,275	2,300	301	282	168
625	650	15	0	0	1,475	1,500	162	143	29	2,300	2,325	305	286	172
650	675	20	3	0	1,500	1,525	167	148	34	2,325	2,350	309	290	176
675	700	24	6	0	1,525	1,550	171	152	38	2,350	2,375	314	295	181
700	725	28	9	0	1,550	1,575	175	156	42	2,375	2,400	318	299	185
725	750	33	14	0	1,575	1,600	180	161	47	2,400	2,425	322	303	189
750	775	37	18	0	1,600	1,625	184	165	51	2,425	2,450	327	308	194
775	800	41	22	0	1,625	1,650	188	169	55	2,450	2,475	331	312	198
800	825	46	27	0	1,650	1,675	193	174	60	2,475	2,500	335	316	202
825	850	50	31	0	1,675	1,700	197	178	64	2,500	2,525	340	321	207
850	875	54	35	0	1,700	1,725	201	182	68	2,525	2,550	344	325	211
875	900	59	40	0	1,725	1,750	206	187	73	2,550	2,575	348	329	215
900	925	63	44	0	1,750	1,775	210	191	77	2,575	2,600	353	334	220
925	950	67	48	0	1,775	1,800	214	195	81	2,600	2,625	357	338	224
950	975	71	52	0	1,800	1,825	218	199	85	2,625	2,650	361	342	228
975	1,000	76	57	0	1,825	1,850	223	204	90	2,650	2,675	366	347	233
1,000	1,025	80	61	0	1,850	1,875	227	208	94	2,675	2,700	371	351	237
1,025	1,050	84	65	0	1,875	1,900	231	212	98	2,700	2,725	376	355	241
1,050	1,075	89	70	0	1,900	1,925	236	217	103	2,725	2,750	381	359	245
1,075	1,100	93	74	0	1,925	1,950	240	221	107	2,750	2,775	386	364	250
1,100	1,125	97	78	0	1,950	1,975	244	225	111	2,775	2,800	391	369	254
1,125	1,150	102	83	0	1,975	2,000	249	230	116	2,800	2,825	396	374	258
1,150	1,175	106	87	0	2,000	2,025	253	234	120	2,825	2,850	401	379	263
1,175	1,200	110	91	0	2,025	2,050	257	238	124	2,850	2,875	406	384	267
1,200	1,225	115	96	0	2,050	2,075	262	243	129	2,875	2,900	411	389	271
1,225	1,250	119	100	0	2,075	2,100	266	247	133	2,900	2,925	416	394	276
1,250	1,275	123	104	0	2,100	2,125	270	251	137	2,925	2,950	421	399	280
1,275	1,300	128	109	1	2,125	2,150	275	256	142	2,950	2,975	426	404	284
1,300	1,325	132	113	4	2,150	2,175	279	260	146	2,975	3,000	431	409	289
1,325	1,350	136	117	7										

The income to be reported in this return is gross income (not including income which is wholly exempt from income tax) without any deductions. The taxes in the above table make allowance for personal exemption, earned income credit, and deductions aggregating 6 percent of gross income.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1942 16—31231-1

FORM 1040 A
TREASURY DEPARTMENT
INTERNAL REVENUE SERVICE

OPTIONAL
UNITED STATES

INDIVIDUAL INCOME TAX RETURN

THIS RETURN MAY BE FILED INSTEAD OF FORM 1040 BY CITIZENS (OR RESIDENT ALIENS) REPORTING ON THE CASH BASIS IF GROSS INCOME IS NOT MORE THAN $3,000 AND IS ONLY FROM SALARY, WAGES, DIVIDENDS, INTEREST, AND ANNUITIES

CALENDAR YEAR
1942

PRINT NAME AND HOME OR RESIDENTIAL ADDRESS PLAINLY BELOW

(Name) (Use given names of both husband and wife, if this is a joint return)

(Street and number, or rural route)

(Post office) (County) (State)

Occupation _____ Social Security number, if any _____

Name and address of employer _____

(If you had more than one employer, attach statement showing name and address and amount received from each)

Do not write in these spaces

Serial No. _____

Amount Paid, $ _____

(Cashier's Stamp)

Cash—Check—M. O.

DEPENDENTS ON JULY 1, 1942

List persons (other than husband or wife) *deriving their chief support from you* if they are under 18 years of age or if they are mentally or physically incapable of self-support

NAME OF DEPENDENT	RELATIONSHIP	IF 18 YEARS OF AGE OR OVER, GIVE REASON FOR LISTING

*GROSS INCOME LESS ALLOWANCE FOR DEPENDENTS

1. Salary, wages, and compensation for personal services	$	
2. Dividends, interest, and annuities		
3. Total	$	
4. Less: $385 for each dependent		
(If you are the head of a family (see definition under item 6 on other side) *only because of dependent(s) listed above*, $385 for each listed dependent *except one.*)		
5. INCOME SUBJECT TO TAX	$	

TAX

6. Tax on item 5 (from Column A, B, or C of table on other side)	$	

I/we declare, under the penalties of perjury, that this return has been examined by me/us, and, to the best of my/our knowledge and belief, is a true, correct, and complete return, made in good faith, for the taxable year stated, pursuant to the Internal Revenue Code and regulations issued under authority thereof; and that I/we had no income from sources other than stated hereon.

_____, 1943.
(Date)*

_____
(Signature)

_____
(Signature)
(If this return includes gross income of both husband and wife, it must be signed by both.)

Filing requirement.—An income tax return must be filed by single persons having a gross income (item 3 above) of $500 or more and married persons having a gross income either separately or combined of $1,200 or more.

**Military and naval personnel.*—Members of the military or naval forces of the United States below the grade of commissioned officer on December 31, 1942, should not include in gross income the first $250 if single on such date, or the first $300 if married or head of a family on such date, received as compensation for active service.

Returns of husband and wife.—Husband and wife may use this form as a joint return if they were living together on July 1, 1942, and if their combined gross income for the calendar year is not more than $3,000. A separate return may be made on this form if the gross income for the calendar year of the one filing the return is not more than $3,000, except that in the case of a husband and wife living together at any time during the calendar year separate returns may not be made on this form unless each elects to use this form.

Allowance for dependents.—Allowance of $385 for each dependent is applicable when this form is used. Where Form 1040 is used, the allowance for each dependent is $350.

Amended returns.—If a qualified taxpayer elects to use this form, amended return may not be made on Form 1040.

Filing of returns and payment of tax.—The return must be filed with the Collector of Internal Revenue for your district on or before March 15, 1943. The tax may be paid in equal quarterly installments commencing March 15, 1943. Pay tax, if any, to the Collector and if payment is made by check or money order, make payable to "Collector of Internal Revenue."

16—31231-1

INDICATE YOUR STATUS ON JULY 1, 1942, BY PLACING CHECK MARK (✓) IN THE APPLICABLE BLOCK (☐) BELOW

1. Single (and not head of family) on July 1, 1942..... ☐

2. Married and not living with husband or wife (and not head of family) on July 1, 1942..... ☐

IF YOU CHECKED No. 1 OR No. 2 ABOVE, FIND YOUR TAX IN COLUMN A

3. Married and living with husband or wife on July 1, 1942, but each filing separate returns on this form.. ☐

IF YOU CHECKED No. 3 ABOVE, FIND YOUR TAX IN COLUMN B

4. Married and living with husband or wife on July 1, 1942, and spouse had no gross income for the entire year..... ☐

5. Married and living with husband or wife on July 1, 1942, and this return includes gross income of both husband and wife for the entire year..... ☐

6. Head of family (a single person or married person not living with husband or wife who exercises family control and supports closely connected dependent relative(s) in one household) on July 1, 1942..... ☐
(State number of such dependent relatives .....)

IF YOU CHECKED No. 4, 5, OR 6 ABOVE, FIND YOUR TAX IN COLUMN C

IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C	IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C	IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C
Over	But not over	Your tax is	Your tax is	Your tax is	Over	But not over	Your tax is	Your tax is	Your tax is	Over	But not over	Your tax is	Your tax is	Your tax is
$0	$525	$0	$0	$0	$1,350	$1,375	$141	$122	$10	$2,175	$2,200	$283	$264	$150
525	550	1	0	0	1,375	1,400	145	126	14	2,200	2,225	288	269	155
550	575	4	0	0	1,400	1,425	149	130	17	2,225	2,250	292	273	159
575	600	7	0	0	1,425	1,450	154	135	21	2,250	2,275	296	277	163
600	625	11	0	0	1,450	1,475	158	139	25	2,275	2,300	301	282	168
625	650	15	0	0	1,475	1,500	162	143	29	2,300	2,325	305	286	172
650	675	20	3	0	1,500	1,525	167	148	34	2,325	2,350	309	290	176
675	700	24	6	0	1,525	1,550	171	152	38	2,350	2,375	314	295	181
700	725	28	9	0	1,550	1,575	175	156	42	2,375	2,400	318	299	185
725	750	33	14	0	1,575	1,600	180	161	47	2,400	2,425	322	303	189
750	775	37	18	0	1,600	1,625	184	165	51	2,425	2,450	327	308	194
775	800	41	22	0	1,625	1,650	188	169	55	2,450	2,475	331	312	198
800	825	46	27	0	1,650	1,675	193	174	60	2,475	2,500	335	316	202
825	850	50	31	0	1,675	1,700	197	178	64	2,500	2,525	340	321	207
850	875	54	35	0	1,700	1,725	201	182	68	2,525	2,550	344	325	211
875	900	59	40	0	1,725	1,750	206	187	73	2,550	2,575	348	329	215
900	925	63	44	0	1,750	1,775	210	191	77	2,575	2,600	353	334	220
925	950	67	48	0	1,775	1,800	214	195	81	2,600	2,625	357	338	224
950	975	71	52	0	1,800	1,825	218	199	85	2,625	2,650	361	342	228
975	1,000	76	57	0	1,825	1,850	223	204	90	2,650	2,675	366	347	233
1,000	1,025	80	61	0	1,850	1,875	227	208	94	2,675	2,700	371	351	237
1,025	1,050	84	65	0	1,875	1,900	231	212	98	2,700	2,725	376	355	241
1,050	1,075	89	70	0	1,900	1,925	236	217	103	2,725	2,750	381	359	245
1,075	1,100	93	74	0	1,925	1,950	240	221	107	2,750	2,775	386	364	250
1,100	1,125	97	78	0	1,950	1,975	244	225	111	2,775	2,800	391	369	254
1,125	1,150	102	83	0	1,975	2,000	249	230	116	2,800	2,825	396	374	258
1,150	1,175	106	87	0	2,000	2,025	253	234	120	2,825	2,850	401	379	263
1,175	1,200	110	91	0	2,025	2,050	257	238	124	2,850	2,875	406	384	267
1,200	1,225	115	96	0	2,050	2,075	262	243	129	2,875	2,900	411	389	271
1,225	1,250	119	100	0	2,075	2,100	266	247	133	2,900	2,925	416	394	276
1,250	1,275	123	104	0	2,100	2,125	270	251	137	2,925	2,950	421	399	280
1,275	1,300	128	109	1	2,125	2,150	275	256	142	2,950	2,975	426	404	284
1,300	1,325	132	113	4	2,150	2,175	279	260	146	2,975	3,000	431	409	289
1,325	1,350	136	117	7										

The income to be reported in this return is gross income (not including income which is wholly exempt from income tax) without any deductions. The taxes in the above table make allowance for personal exemption, earned income credit, and deductions aggregating 6 percent of gross income.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1942 16—81231-1

FORM 1040 A
TREASURY DEPARTMENT
INTERNAL REVENUE SERVICE

OPTIONAL

UNITED STATES INDIVIDUAL INCOME TAX RETURN

CALENDAR YEAR 1942

THIS RETURN MAY BE FILED INSTEAD OF FORM 1040 BY CITIZENS (OR RESIDENT ALIENS) REPORTING ON THE CASH BASIS IF GROSS INCOME IS NOT MORE THAN $3,000 AND IS ONLY FROM SALARY, WAGES, DIVIDENDS, INTEREST, AND ANNUITIES

Do not write in these spaces

Serial No. _____

Amount Paid, $ _____

(Cashier's Stamp)

6/9/43

PRINT NAME AND HOME OR RESIDENTIAL ADDRESS PLAINLY BELOW

_____
(Name) (Use given names of both husband and wife, if this is a joint return)

_____
(Street and number, or rural route)

_____
(Post office) (County) (State)

Occupation _____ Social Security number, if any _____

Name and address of employer _____

(If you had more than one employer, attach statement showing name and address and amount received from each)

Cash—Check—M. O.

DEPENDENTS ON JULY 1, 1942

List persons (other than husband or wife) *deriving their chief support from you* if they are under 18 years of age or if they are mentally or physically incapable of self-support

NAME OF DEPENDENT	RELATIONSHIP	IF 18 YEARS OF AGE OR OVER, GIVE REASON FOR LISTING

*GROSS INCOME LESS ALLOWANCE FOR DEPENDENTS

1. Salary, wages, and compensation for personal services	$	
2. Dividends, interest, and annuities		
3. Total	$	
4. Less: $385 for each dependent		
(If you are the head of a family (see definition under item 6 on other side) *only because of dependent(s) listed above*, $385 for each listed dependent *except one*.)		
5. INCOME SUBJECT TO TAX	$	

TAX

6. Tax on item 5 (from Column A, B, or C of table on other side)	$	

I/we declare, under the penalties of perjury, that this return has been examined by me/us, and, to the best of my/our knowledge and belief, is a true, correct, and complete return, made in good faith, for the taxable year stated, pursuant to the Internal Revenue Code and regulations issued under authority thereof; and that I/we had no income from sources other than stated hereon.

_____, 1943.
(Date)

_____
(Signature)

_____
(Signature)

(If this return includes gross income of both husband and wife, it must be signed by both.)

Filing requirement.—An income tax return must be filed by single persons having a gross income (item 3 above) of $500 or more and married persons having a gross income either separately or combined of $1,200 or more.

**Military and naval personnel.*—Members of the military or naval forces of the United States below the grade of commissioned officer on December 31, 1942, should not include in gross income the first $250 if single on such date, or the first $300 if married or head of a family on such date, received as compensation for active service.

Returns of husband and wife.—Husband and wife may use this form as a joint return if they were living together on July 1, 1942, and if their combined gross income for the calendar year is not more than $3,000. A separate return may be made on this form if the gross income for the calendar year of the one filing the return is not more than $3,000, except that in the case of a husband and wife living together at any time during the calendar year separate returns may not be made on this form unless each elects to use this form.

Allowance for dependents.—Allowance of $385 for each dependent is applicable when this form is used. Where Form 1040 is used, the allowance for each dependent is $350.

Amended returns.—If a qualified taxpayer elects to use this form, amended return may not be made on Form 1040.

Filing of returns and payment of tax.—The return must be filed with the Collector of Internal Revenue for your district on or before March 15, 1943. The tax may be paid in equal quarterly installments commencing March 15, 1943. Pay tax, if any, to the Collector and if payment is made by check or money order, make payable to "Collector of Internal Revenue."

16—31231-1

INDICATE YOUR STATUS ON JULY 1, 1942, BY PLACING CHECK MARK (✓) IN THE APPLICABLE BLOCK (☐) BELOW

1. Single (and not head of family) on [redacted] 1, 1942..... ☐

2. Married and not living with husband or wife (and not head of family) on July 1, 1942..... ☐

IF YOU CHECKED No. 1 OR No. 2 ABOVE, FIND YOUR TAX IN COLUMN A

3. Married and living with husband or wife on July 1, 1942, but each filing separate returns on this form... ☐

IF YOU CHECKED No. 3 ABOVE, FIND YOUR TAX IN COLUMN B

4. Married and livi[redacted]ith husband or wife on July 1, 1942, and spouse had no gross income for the entire year..... ☐

5. Married and living with husband or wife on July 1, 1942, and this return includes gross income of both husband and wife for the entire year..... ☐

6. Head of family (a single person or married person not living with husband or wife who exercises family control and supports closely connected dependent relative(s) in one household) on July 1, 1942..... ☐
(State number of such dependent relatives .....)

IF YOU CHECKED No. 4, 5, OR 6 ABOVE, FIND YOUR TAX IN COLUMN C

IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C	IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C	IF Income subject to tax (item 5 on other side) is		COLUMN A	COLUMN B	COLUMN C
Over	But not over	Your tax is	Your tax is	Your tax is	Over	But not over	Your tax is	Your tax is	Your tax is	Over	But not over	Your tax is	Your tax is	Your tax is
$0	$525	$0	$0	$0	$1,350	$1,375	$141	$122	$10	$2,175	$2,200	$283	$264	$150
525	550	1	0	0	1,375	1,400	145	126	14	2,200	2,225	288	269	155
550	575	4	0	0	1,400	1,425	149	130	17	2,225	2,250	292	273	159
575	600	7	0	0	1,425	1,450	154	135	21	2,250	2,275	296	277	163
600	625	11	0	0	1,450	1,475	158	139	25	2,275	2,300	301	282	168
625	650	15	0	0	1,475	1,500	162	143	29	2,300	2,325	305	286	172
650	675	20	3	0	1,500	1,525	167	148	34	2,325	2,350	309	290	176
675	700	24	6	0	1,525	1,550	171	152	38	2,350	2,375	314	295	181
700	725	28	9	0	1,550	1,575	175	156	42	2,375	2,400	318	299	185
725	750	33	14	0	1,575	1,600	180	161	47	2,400	2,425	322	303	189
750	775	37	18	0	1,600	1,625	184	165	51	2,425	2,450	327	308	194
775	800	41	22	0	1,625	1,650	188	169	55	2,450	2,475	331	312	198
800	825	46	27	0	1,650	1,675	193	174	60	2,475	2,500	335	316	202
825	850	50	31	0	1,675	1,700	197	178	64	2,500	2,525	340	321	207
850	875	54	35	0	1,700	1,725	201	182	68	2,525	2,550	344	325	211
875	900	59	40	0	1,725	1,750	206	187	73	2,550	2,575	348	329	215
900	925	63	44	0	1,750	1,775	210	191	77	2,575	2,600	353	334	220
925	950	67	48	0	1,775	1,800	214	195	81	2,600	2,625	357	338	224
950	975	71	52	0	1,800	1,825	218	199	85	2,625	2,650	361	342	228
975	1,000	76	57	0	1,825	1,850	223	204	90	2,650	2,675	366	347	233
1,000	1,025	80	61	0	1,850	1,875	227	208	94	2,675	2,700	371	351	237
1,025	1,050	84	65	0	1,875	1,900	231	212	98	2,700	2,725	376	355	241
1,050	1,075	89	70	0	1,900	1,925	236	217	103	2,725	2,750	381	359	245
1,075	1,100	93	74	0	1,925	1,950	240	221	107	2,750	2,775	386	364	250
1,100	1,125	97	78	0	1,950	1,975	244	225	111	2,775	2,800	391	369	254
1,125	1,150	102	83	0	1,975	2,000	249	230	116	2,800	2,825	396	374	258
1,150	1,175	106	87	0	2,000	2,025	253	234	120	2,825	2,850	401	379	263
1,175	1,200	110	91	0	2,025	2,050	257	238	124	2,850	2,875	406	384	267
1,200	1,225	115	96	0	2,050	2,075	262	243	129	2,875	2,900	411	389	271
1,225	1,250	119	100	0	2,075	2,100	266	247	133	2,900	2,925	416	394	276
1,250	1,275	123	104	0	2,100	2,125	270	251	137	2,925	2,950	421	399	280
1,275	1,300	128	109	1	2,125	2,150	275	256	142	2,950	2,975	426	404	284
1,300	1,325	132	113	4	2,150	2,175	279	260	146	2,975	3,000	431	409	289
1,325	1,350	136	117	7										

The income to be reported in this return is gross income (not including income which is wholly exempt from income tax) without any deductions. The taxes in the above table make allowance for personal exemption, earned income credit, and deductions aggregating 6 percent of gross income.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1942 16—31231-1

Treasury Department
Internal Revenue Service

UNITED STATES
INDIVIDUAL INCOME TAX RETURN

1942

OPTIONAL FORM 1040A MAY BE FILED INSTEAD OF THIS FORM IF GROSS INCOME IS REPORTED ON THE CASH BASIS FOR THE CALENDAR YEAR, IS NOT MORE THAN $3,000, AND CONSISTS *WHOLLY* OF SALARY, WAGES, OTHER COMPENSATION FOR PERSONAL SERVICES, DIVIDENDS, INTEREST OR ANNUITIES.

(Do not use these spaces)

File Code

Serial No.

District

(Cashier's Stamp)

6/4/30

Cash—Check—M. O.

First Payment

$

FOR CALENDAR YEAR 1942

or fiscal year beginning _____, 1942, and ending _____, 1943

PRINT NAME AND ADDRESS PLAINLY. (See Instruction C)

(Name) (Use given names of both husband and wife, if this is a joint return)

(Street and number, or rural route)

(Post office) (County) (State)

(Occupation) (Social Security number, if any)

(Name and address of employer)

(If more than one employer, attach statement showing name and address and amount received from each)

Item and Instruction No.	INCOME	Amount	Deductible Expenses (Attach itemized statement)		
1.	Salaries and other compensation for personal services, $	$	$		
2.	Dividends				
3.	Interest on bank deposits, notes, etc.				
			Less amortizable bond premium		
4.	Interest on corporation bonds, etc.	$	$		
5.	Interest on Government obligations, etc.:				
	(*a*) From line (*h*), Schedule A	$	$		
	(*b*) From line (*i*), Schedule A	$	$		
6.	Rents and royalties. (From Schedule B)				
7.	Annuities				
	ITEMS 8, 9, AND 10, BELOW (AND PAGES 3 AND 4) NEED NOT BE CONSIDERED UNLESS YOU HAVE INCOME (OR LOSSES) IN ADDITION TO ITEMS ABOVE.				
8.	(*a*) Net gain (or loss) from sale or exchange of capital assets. (From Schedule F)				
	(*b*) Net gain (or loss) from sale or exchange of property other than capital assets. (From Schedule G)				
9.	Net profit (or loss) from business or profession. (From Schedule H)				
	(State total receipts, from line 1, Schedule H, $_____)				
10.	Income (or loss) from partnerships; fiduciary income; and other income. (From Schedule I)				
11.	Total income in items 1 to 10				$
	DEDUCTIONS				
12.	Contributions paid. (Explain in Schedule C)			$	
13.	Interest. (Explain in Schedule C)				
14.	Taxes. (Explain in Schedule C)				
15.	Losses from fire, storm, shipwreck, or other casualty, or theft. (Explain in Schedule C)				
16.	Bad debts. (Explain in Schedule C)				
17.	Other deductions authorized by law. (Explain in Schedule C)				
18.	Total deductions in items 12 to 17				
19.	Net income (item 11 minus item 18)				$

COMPUTATION OF TAX

20.	Net income (item 19 above)		$	
21.	Less: Personal exemption. (From Schedule D-1)	$		
22.	Credit for dependents. (From Schedule D-2)			
23.	Balance (surtax net income)		$	
24.	Less: Item 5 (*a*) above	$		
25.	Earned income credit. (From Schedule E-1 or E-2)			
26.	Balance subject to normal tax		$	
27.	Normal tax (6% of item 26)		$	
28.	Surtax on item 23. (See Instruction 28)			
29.	Total (item 27 plus item 28)		$	
30.	Total tax (Item 29 or line 16, Schedule F)		$	
31.	Less: Income tax paid at source	$		
32.	Income tax paid to a foreign country or U. S. possession. (Attach Form 1116)			
33.	Balance of tax (Item 30 minus items 31 and 32)		$	

I/we declare, under the penalties of perjury, that this return (including any accompanying schedules and statements) has been examined by me/us, and to the best of my/our knowledge and belief is a true, correct, and complete return, made in good faith, for the taxable year stated, pursuant to the Internal Revenue Code and the regulations issued under authority thereof.

(Signature of person (other than taxpayer or agent) preparing return) (Date)

(Name of firm or employer, if any)

(Signature of taxpayer) (Date)

(If this is a joint return (not made by agent), it must be signed by both husband and wife)
A return made by an agent must be accompanied by power of attorney. (See Instruction F)

16—24240-1

Schedule A.—INTEREST ON GOVERNMENT OBLIGATIONS, ETC. (See Instruction 5)

1. Obligations or securities	2. Amount owned at end of year including your proportionate share of such obligations held by estates, trusts, partnerships, or common trust funds	3. Interest received or accrued during the year	4. Amount of principal, interest on which is exempt from taxation	5. Interest on amount in excess of exemption, and dividends subject to surtax only
(a) Obligations of a State, Territory, or political subdivision thereof, or the District of Columbia, or United States possessions	$	$	All	xxxxxxxx
(b) Obligations issued prior to March 1, 1941, under Federal Farm Loan Act, or under such Act as amended			All	xxxxxxxx
(c) Obligations of United States issued on or before September 1, 1917			All	xxxxxxxx
(d) Treasury Notes issued prior to December 1, 1940, Treasury Bills and Treasury Certificates of Indebtedness issued prior to March 1, 1941			All	xxxxxxxx
(e) United States Savings Bonds and Treasury Bonds issued prior to March 1, 1941			$5,000	$
(f) Obligations of instrumentalities of the United States (other than obligations to be reported in (b) above) issued prior to March 1, 1941			None	
(g) Dividends on share accounts in Federal savings and loan associations in case of shares issued prior to March 28, 1942	xxxxxxxxxxxxx	xxxxxxxxx	x x x	
(h) Total (enter as item 5 (a), page 1)				$

	Amount owned at end of year	Interest received or accrued during the year (subject to normal tax and surtax)
(i) Treasury Notes issued on or after December 1, 1940, and obligations issued on or after March 1, 1941, by the United States or any agency or instrumentality thereof (enter amount of interest as item 5 (b), page 1)	$	$

Schedule B.—INCOME FROM RENTS AND ROYALTIES. (See Instruction 6)

1. Kind of property	2. Amount	3. Depreciation or depletion (attach schedule)	4. Repairs (explain below)	5. Other expenses (itemize below)	6. Net profit (column 2 minus sum of columns 3, 4, and 5) (enter as item 6, page 1)
	$	$	$	$	$

Explanation of deductions claimed in columns 4 and 5 _____

Schedule C.—EXPLANATION OF DEDUCTIONS CLAIMED IN ITEMS 12, 13, 14, 15, 16, AND 17

1. Item No.	2. Explanation	3. Amount	1. Item No. (Continued)	2. Explanation (Continued)	3. Amount (Continued)
		$			$

Schedule D.—EXPLANATION OF CREDITS CLAIMED IN ITEMS 21 AND 22. (See Instructions 21 and 22)

(1) Personal Exemption

Status	Number of months during the year in each status	Credit claimed
Single, or married and not living with husband or wife, and not head of family		$
Married and living with husband or wife		
Head of family (explain below)		

(2) Credit for Dependents

Name of dependent and relationship	Number of months during the year: Under 18 years old	Number of months during the year: 18 years or over	Credit claimed
			$

Reason for support if 18 years or over _____

Schedule E.—COMPUTATION OF EARNED INCOME CREDIT. (See Instruction 25)

(1) If your net income is $3,000 or less, use only this part of schedule

Net income (item 19, page 1)	$
Earned income credit (10% of net income, above)	

(2) If your net income is more than $3,000, use only this part of schedule

Earned net income (not more than $14,000)	$
Net income (item 19, page 1)	
Earned income credit (10% of earned net income or 10% of net income, above, whichever amount is smaller, but do not enter less than $300)	

QUESTIONS

1. Did you file a return for any prior year? _____ If so, what was the latest year? _____ To which Collector's office was it sent? _____
2. If separate return was made for the current year, state:
   (a) Name of husband or wife _____
   (b) Personal exemption, if any, claimed thereon _____
   (c) Collector's office to which it was sent _____
4. Was the rate of your salary or wages increased or decreased after October 3, 1942, and before the end of your taxable year? _____ (Yes or no)
5. Did you receive during your taxable year any amount claimed to be nontaxable other than interest reported in Schedule A (see Instruction H)? _____ If so, attach schedule showing source, nature, and amount of such income.
6. Did you at any time during your taxable year own directly or indirectly any stock of a foreign corporation or a personal holding company as defined by section 501 of the Internal Revenue Code? _____ If so,

Schedule F.—GAINS AND LOSSES FROM SALES OR EXCHANGES OF CAPITAL ASSETS. (See Instruction 8)

1. Kind of property (if necessary, attach statement of descriptive details not shown below)	2. Date acquired (Mo. Day Year)	3. Date sold (Mo. Day Year)	4. Gross sales price (contract price)	5. Cost or other basis	6. Expense of sale and cost of improvements subsequent to acquisition or March 1, 1913	7. Depreciation allowed (or allowable) since acquisition or March 1, 1913 (explain in Schedule J)	8. Gain or loss (column 4 plus column 7 minus the sum of columns 5 and 6)	Gain or loss to be taken into account: 9. Percentage	10. Amount
SHORT-TERM CAPITAL GAINS AND LOSSES—ASSETS HELD NOT MORE THAN 6 MONTHS									
			$	$	$	$	$	100	$
								100	
								100	
								100	
Total net short-term capital gain or loss (enter in line 1, column 3, of summary below)									$
LONG-TERM CAPITAL GAINS AND LOSSES—ASSETS HELD FOR MORE THAN 6 MONTHS									
			$	$	$	$	$	50	
								50	
								50	
								50	
Total net long-term capital gain or loss (enter in line 2, column 3, of summary below)									$

SUMMARY OF CAPITAL GAINS AND LOSSES

1. Classification	2. Net short-term capital loss of preceding taxable year (not in excess of net income for such year), but only to extent of net short-term capital gain of current year	3. Net gain or loss to be taken into account from column 10, above: (a) Gain	3. (b) Loss	4. Net gain or loss to be taken into account from partnerships and common trust funds: (a) Gain	4. (b) Loss	5. Total net gain or loss taken into account in columns 2, 3, and 4 of this summary: (a) Gain	5. (b) Loss
1. Total net short-term capital gain or loss	$	$	$	$	$	$	$
2. Total net long-term capital gain or loss		$	$	$	$	$	$
3. Net gain in column 5, lines 1 and 2. (Enter as item 8 (a), page 1)						$	x x x x x x x x
4. Net loss in column 5, lines 1 and 2. (The amount to be entered as item 8 (a), page 1, is (1) this item or (2) net income, computed without regard to capital gains or losses, or (3) $1,000, whichever is smallest)						x x x x x x x x	$

COMPUTATION OF ALTERNATIVE TAX

Use only if you had an excess of net long-term *capital gain* over net short-term *capital loss*, and item 23, page 1, exceeds $18,000

1. Net income (item 19, page 1)	$	10. Normal tax (6% of line 9)	$
2. Excess of net long-term capital gain over net short-term capital loss (line 2, column 5 (a), minus line 1, column 5(b), of summary above)		11. Surtax on line 6. (See Instruction 28)	
3. Ordinary net income (line 1 minus line 2)	$	12. Partial tax (line 10 plus line 11)	$
4. Less: Personal exemption. (From Schedule D–1)	$	13. 50% of line 2	
5. Credit for dependents. (From Schedule D–2)			
6. Balance (surtax net income)	$	14. Alternative tax (line 12 plus line 13)	$
7. Less: Item 5 (a), page 1	$	15. Total normal tax and surtax (item 29, page 1)	$
8. Earned income credit. (From Schedule E–1 or E–2)		16. Tax liability (line 14 or line 15, whichever is the lesser). (Enter as item 30, page 1)	$
9. Balance subject to normal tax	$		

Schedule G.—GAINS AND LOSSES FROM SALES OR EXCHANGES OF PROPERTY OTHER THAN CAPITAL ASSETS (See Instruction 8)

1. Kind of property	2. Date acquired	3. Gross sales price (contract price)	4. Cost or other basis	5. Expense of sale and cost of improvements subsequent to acquisition or March 1, 1913	6. Depreciation allowed (or allowable) since acquisition or March 1, 1913 (explain in Schedule J)	7. Gain or loss (column 3 plus column 6 minus the sum of columns 4 and 5)
		$	$	$	$	$
Total net gain (or loss) (enter as item 8 (b), page 1)						$

State the family, fiduciary, or business relationship to you, if any, of purchaser of any of the items on this page _____

If any of such items were acquired by you other than by purchase, explain fully how acquired _____

Schedule H.—PROFIT (OR LOSS) FROM BUSINESS OR PROFESSION. (See Instruction 9)

(State (1) nature of business _____; (2) number of places of business _____; (3) business name and address if different from name and address on page 1 _____)

1. Total receipts _____ $ _____

COST OF GOODS SOLD (To be used where inventories are an income-determining factor)		OTHER BUSINESS DEDUCTIONS	
2. Inventory at beginning of year	$	11. Salaries and wages not included as "Labor" (do not deduct compensation for yourself)	$
3. Merchandise bought for sale		12. Interest on business indebtedness	
4. Labor		13. Taxes on business and business property	
5. Material and supplies		14. Losses (explain below)	
6. Other costs (itemize below)		15. Bad debts arising from sales or services	
7. Total of lines 2 to 6	$	16. Depreciation, obsolescence, and depletion (explain in Schedule J)	
8. Less inventory at end of year		17. Rent, repairs, and other expenses (itemize below or on separate sheet)	
9. Net cost of goods sold (line 7 minus line 8)	$	18. Amortization of emergency facilities (attach statement)	
10. Gross profit (line 1 minus line 9)	$	19. Total of lines 11 to 18	$
		20. Total of lines 9 and 19	$
		21. Net profit (or loss) (line 1 minus line 20) (enter as item 9, page 1)	$

If the production, manufacture, purchase, or sale of merchandise is an income-producing factor, inventories are required. Enter "C," or "C or M," on lines 2 and 8 to indicate whether inventories are valued at cost, or cost or market, whichever is lower.

Explanation of deductions claimed in lines 6, 14, and 17 _____

Did you at any time after October 3, 1942, and before the end of your taxable year have in your employ more than eight individuals? _____ (Yes or No)

If answer is "Yes," have you in this return taken a deduction for any amount of wages or salaries representing an increase or decrease in rate after October 3, 1942? _____ (Yes or No) If answer to second question is "Yes," attach a statement explaining all such increases or decreases. If any of such increases or decreases required the prior approval of the National War Labor Board or the Commissioner of Internal Revenue as stated in Instruction 9, attach also a copy of the authorization for each of such increases or decreases.

Schedule I.—INCOME FROM PARTNERSHIPS, FIDUCIARIES, AND OTHER SOURCES

INCOME (OR LOSS) FROM PARTNERSHIPS, SYNDICATES, ETC. (SEE INSTRUCTION 10 (a)) (FURNISH NAMES AND ADDRESSES)		
	$	
		$
INCOME FROM FIDUCIARIES (FURNISH NAMES AND ADDRESSES)		
	$	
INCOME FROM OTHER SOURCES (STATE NATURE)		
	$	
Total amounts in Schedule I. (Enter as item 10, page 1)		$

Schedule J.—EXPLANATION OF DEDUCTION FOR DEPRECIATION CLAIMED IN SCHEDULES F, G, AND H

1. Kind of property (If buildings, state material of which constructed)	2. Date acquired	3. Cost or other basis (Do not include land or other nondepreciable property)	4. Assets fully depreciated in use at end of year	5. Depreciation allowed (or allowable) in prior years	6. Remaining cost or other basis to be recovered	7. Estimated life used in accumulating depreciation	8. Estimated remaining life from beginning of year	9. Depreciation allowable this year
		$	$	$	$			$

☆ U. S. GOVERNMENT PRINTING OFFICE : 1942 16—24210-1

INSTRUCTIONS ON THIS PAGE NEED BE CONSIDERED ONLY IF ENTRIES ARE MADE IN ITEMS 8, 9, AND 10, PAGE 1 OF RETURN

8. GAINS AND LOSSES FROM SALES OR EXCHANGES OF CAPITAL ASSETS AND OTHER PROPERTY.—Report details in Schedules F and G.

"Capital assets" defined.—The term "capital assets" means property held by the taxpayer (whether or not connected with his trade or business), but not stock in trade or other property of a kind which would properly be included in his inventory if on hand at the close of the taxable year, or property held by the taxpayer primarily for sale to customers in the ordinary course of his trade or business, or property used in the trade or business of a character which is subject to the allowance for depreciation provided in section 23 (l), or an obligation of the United States or any of its possessions, or of a State or Territory, or any political subdivision thereof, or of the District of Columbia, issued on or after March 1, 1941, on a discount basis and payable without interest at a fixed maturity date not exceeding one year from the date of issue, or real property used in the trade or business of the taxpayer.

Section 165 (b) provides that if an employee receives the total distribution that he is entitled to under an employees' trust plan that meets the requirements of section 165 (a) in one taxable year on account of his separation from service, the amount of such distribution to the extent exceeding the amounts contributed by the employee shall be considered a gain from the sale or exchange of a capital asset held for more than 6 months.

A capital gain dividend, as defined in section 362 (relating to tax on regulated investment companies) shall be treated by the shareholder as gains from the sale or exchange of capital assets held for more than 6 months.

For special treatment of gains and losses from involuntary conversion, and from sale or exchange of certain property used in the trade or business, see section 117 (j).

Description of property.—State following facts: (*a*) For real estate, location and description of land and improvements; (*b*) for bonds or other evidences of indebtedness, name of issuing corporation, particular issue, denomination and amount; and (c) for stocks, name of corporation, class of stock, number of shares, and capital changes affecting basis (including nontaxable distributions).

Basis.—In determining GAIN in case of property acquired before March 1, 1913, use the cost or the fair market value as of March 1, 1913, adjusted as provided in section 113 (b), whichever is greater, but in determining LOSS use cost so adjusted. If the property was acquired after February 28, 1913, use cost, except as otherwise provided in section 113.

Losses on securities becoming worthless.—If (1) shares of stock become worthless during the year or (2) corporate securities with interest coupons or in registered form become worthless during the year, and are capital assets, the loss therefrom shall be considered as from the sale or exchange of capital assets as of the last day of such taxable year.

Classification of capital gains and losses.—The phrase "short-term" applies to gains and losses from the sale or exchange of capital assets held for 6 months or less; the phrase "long-term" to capital assets held for more than 6 months.

LIMITATION ON CAPITAL LOSSES.—Losses from sales or exchanges of capital assets shall be allowed only to the extent of the gains from such sales or exchanges, plus the net income (computed without regard to capital gains and losses) or $1,000, whichever is smaller. However, the amount of the net short-term capital loss of the last taxable year beginning in 1941 (computed without regard to amounts treated as short-term capital losses from the preceding taxable year), which is not in excess of the net income for such year, shall, to the extent of the net short-term capital gain for the succeeding taxable year, be a short-term capital loss of such succeeding taxable year.

ALTERNATIVE TAX.—If the net long-term capital gain exceeds the net short-term capital loss, an alternative tax may be imposed in lieu of the normal tax and surtax imposed on net income. (See Computation of Alternative Tax, Schedule F.)

"Wash sales" losses.—Loss from sale or other disposition of stocks or securities cannot be deducted unless sustained in connection with the taxpayer's trade or business, if, within 30 days before or after the date of sale or other disposition, the taxpayer has acquired (by purchase or by an exchange upon which the entire amount of gain or loss was recognized by law), or has entered into a contract or option to acquire, substantially identical stock or securities.

Losses in transactions between certain persons.—No deduction is allowable for losses from sales or exchanges of property directly or indirectly between (*a*) members of a family, (*b*) a corporation and an individual owning more than 50 percent of its stock (liquidations excepted), (*c*) a grantor and fiduciary of any trust, or (*d*) a fiduciary and a beneficiary of the same trust.

9. BUSINESS OR PROFESSION.—Fill in Schedule H. Farmers keeping no books of account, or books on cash basis, must attach Form 1040F in lieu of Schedule H. A taxpayer electing to include in gross income amounts received during the year as loans from the Commodity Credit Corporation should file with his return a statement showing the details of such loans. (See section 123.)

If installment method is used, attach schedule showing separately for years 1939, 1940, 1941, and 1942: (*a*) Gross sales; (*b*) cost of goods sold; (*c*) gross profits; (*d*) percentage of profits to gross sales; (*e*) amount collected; and (*f*) gross profit on amount collected.

Bad debts may be deducted either (1) when they become wholly or partially worthless, or (2) by a reasonable addition to a reserve. (No change of method without permission of Commissioner.)

Except as stated below, if any increase or decrease in salary or wages is made after October 3, 1942, without the prior approval of the National War Labor Board or the Commissioner of Internal Revenue, no amount of such salary or wages paid or accrued in contravention of the Act of October 2, 1942, entitled "An Act to amend the Emergency Price Control Act of 1942, to aid in preventing inflation, and for other purposes," or regulations, rulings, or orders promulgated thereunder, is allowable as a deduction. Any increase, however, may be made without the prior approval of the National War Labor Board or the Commissioner of Internal Revenue if it is made in accordance with the terms of an established wage or salary agreement or established wage or salary rate schedule covering the work assignments and it is made as a result of individual promotions or reclassifications, individual merit increases within established rate ranges, operation of an established plan of wage or salary increases based upon length of service, increased productivity under piece-work or incentive plans, or operation of an apprentice or trainee system.

10 (a). INCOME FROM PARTNERSHIPS, FIDUCIARIES, ETC., WHOSE TAXABLE YEAR ENDS WITHIN THE TAXABLE YEAR COVERED BY THIS RETURN.—Enter as item 10 your share of profits (whether received or not) or losses of a partnership (including a syndicate, pool, etc., not taxable as a corporation) except capital gains and losses, which enter in Schedule F. Enter as item 10 income from an estate or trust. Enter in Schedule A your share of interest on obligations of the United States and instrumentalities, issued prior to March 1, 1941, owned by partnership, estate, or trust. Include in item 12, and explain in Schedule C, your share of any contribution or gift, payment of which was made by the partnership within its taxable year. Enter in items 31 and 32, respectively, your share of credits for Federal income tax paid at source and foreign income taxes.

10 (b). OTHER INCOME.—Enter any other taxable income, including earnings of minor children if parent is legally entitled thereto and alimony and separate maintenance income.

☆ U. S. GOVERNMENT PRINTING OFFICE 16—31315-1

(c) The special fund for vocational rehabilitation authorized by section 12 of the World War Veterans' Act, 1924;

(d) Posts or organizations of war veterans, or auxiliary units or societies of any such posts or organizations, if such posts, organizations, units, or societies are organized in the United States or any of its possessions, and if no part of their net earnings inures to the benefit of any private shareholder or individual; or

(e) A domestic fraternal society, order, or association, operating under the lodge system, but only if such contributions or gifts are to be used exclusively for religious, charitable, scientific, literary, or educational purposes, or for the prevention of cruelty to children or animals.

13. INTEREST.—Enter interest on personal indebtedness as distinguished from business indebtedness (which should be entered in Schedules B and H). Do not include interest on indebtedness incurred or continued to purchase or carry obligations (other than obligations of the United States issued after September 24, 1917, and originally subscribed for by the taxpayer) the interest upon which is wholly exempt from taxation. Include tenant-stockholder's proportion of interest paid or incurred by a cooperative apartment corporation on its outstanding indebtedness contracted in the acquisition, construction, alteration, rehabilitation, or maintenance of a cooperative apartment building or in the acquisition of the land on which the building is located. (See section 23 (z).) For limitations on deductions for unpaid expenses and interest, see section 24 (c). Do not deduct amounts paid or accrued on indebtedness incurred or continued to purchase a single premium life insurance or endowment contract. A contract shall be considered a single premium life insurance or endowment contract, if substantially all the premiums on such contract are paid within a period of 4 years from the date on which the contract is purchased.

14. TAXES.—Enter taxes paid or accrued during the taxable year except taxes entered in Schedules B and H and taxes not deductible. The taxes imposed by the United States Government on the following items may be deducted: Admissions, club dues, telephone and telegraph services, safe deposit boxes, transportation of persons and property, use of motor vehicle or boat, and documents. State and local retail sales taxes may be deducted to the extent that they are separately stated and paid by the purchaser. Do not include taxes assessed against local benefits, Federal income taxes or estate, inheritance, legacy, succession, gift taxes, taxes imposed on your interest as shareholder of a corporation which are paid by the corporation without reimbursement from you, nor income taxes claimed as a credit in item 32. Federal social security and employment taxes paid by or for an employee are not deductible by the employee. Include tenant-shareholder's proportion of real estate taxes on a cooperative apartment building and the land on which it is situated, allowable as a deduction under section 23 (c), paid or incurred by the cooperative apartment corporation. (See section 23 (z).)

15. LOSSES.—Enter property losses (not claimed in Schedule H), from fire, storm, shipwreck, or other casualty, or from theft, not compensated for by insurance or otherwise. Include also losses (not claimed in Schedule H) from property destroyed or seized in the course of military or naval operations during the war, and of property located in enemy countries or in areas which come under the control of the enemy. See section 127 for rules as to treatment of losses from war, taxation of property recovered, and basis of property. Explain in Schedule C, giving description of property, date acquired, cost, subsequent improvements, depreciation allowable, insurance, salvage value, and deductibe loss.

16. BAD DEBTS.—Enter bad debts other than those claimed in Schedule H. Show in Schedule C: (*a*) of what the debts consisted; (*b*) name and family relationship, if any, of debtor; (*c*) when created; (*d*) when due; (*e*) efforts made to collect; and (*f*) how determined to be worthless. Enter in Schedule F losses from corporate securities with interest coupons or in registered form which become worthless during the year, and which are capital assets.

17. OTHER DEDUCTIONS.—Enter other authorized deductions, including net operating loss deduction allowed by section 23 (s). Every taxpayer claiming a deduction due to a net operating loss for the preceding taxable year or years shall file with his return the statement required by section 19.122–1 of the regulations. Include alimony and separate maintenance payments to the extent permitted by section 23 (u). Include non-trade or non-business expenses incurred either (1) for the production or collection of taxable income or (2) for the management, conservation, or maintenance of property held for the production of taxable income. Expenses paid, not compensated for by insurance or otherwise, for the diagnosis, cure, mitigation, treatment, or prevention of disease, or for the purpose of affecting any structure or function of the body (including amounts paid for accident or health insurance) of the taxpayer, his spouse, or a dependent of the taxpayer, are deductible. The deduction is limited to such expenses as exceed 5 percent of the net income computed without the benefit of the deduction for expenses paid for such medical care. Where the husband and wife file a joint return the limitation is 5 percent of the aggregate net income of such husband and wife. The maximum deduction in the case of a husband and wife who file a joint return or a head of a family may not exceed $2,500, and in the case of all other individuals, $1,250.

Do not deduct losses in transactions not connected with your trade or business or not entered into for profit. Losses from wagering transactions are allowable to the extent of gains therefrom.

21, 22. CREDIT FOR PERSONAL EXEMPTION AND DEPENDENTS.—A single person, or a married person not living with spouse, is allowed a personal exemption of $500. A person who, during the entire taxable year, was the head of a family or was married and living with spouse, is allowed an exemption of $1,200. On separate returns (Form 1040), the personal exemption may be taken by either husband or wife or divided between them in any proportion.

A "head of a family" is one who supports in one household one or more dependent individuals closely connected with him by blood relationship, relationship by marriage, or by adoption, and whose right to exercise family control is based upon some moral or legal obligation.

A credit of $350 is allowed for each person (other than husband or wife) under 18 years of age, or incapable of self-support because mentally or physically defective, whose chief support was received from the taxpayer. If taxpayer is head of a family only because of dependents for whom he would be entitled to credit under preceding sentence, $350 credit is allowed for each of such dependents except one.

If taxpayer's status, with respect to personal exemption and credit for dependents, changed during the taxable year, such exemption and credit shall be apportioned according to the number of months before and after such change. A fractional part of a month is disregarded unless it exceeds half a month, when it shall be considered a month.

25. EARNED INCOME CREDIT.—"Earned income" means wages, salaries, professional fees, and other amounts received as compensation for personal services actually rendered. Where a taxpayer is engaged in a trade or business in which both personal services and capital are material income-producing factors, a reasonable allowance as compensation for the personal services actually rendered by the taxpayer, not in excess of 20 percent of his share of the net profits of such trade or business, shall be considered as earned income. "Earned net income" means the excess of the amount of the earned income over the sum of the "earned income deductions," which are the ordinary and necessary expenses properly chargeable against earned income.

28. SURTAX.—The following table shows the surtax due for the taxable year upon certain specified amounts of surtax net income.

SURTAX TABLE

If the surtax net income is:	*The surtax shall be:*
Not over $2,000	13% of the surtax net income.
Over $2,000 but not over $4,000	$260, plus 16% of excess over $2,000.
Over $4,000 but not over $6,000	$580, plus 20% of excess over $4,000.
Over $6,000 but not over $8,000	$980, plus 24% of excess over $6,000.
Over $8,000 but not over $10,000	$1,460, plus 28% of excess over $8,000.
Over $10,000 but not over $12,000	$2,020, plus 32% of excess over $10,000.
Over $12,000 but not over $14,000	$2,660, plus 36% of excess over $12,000.
Over $14,000 but not over $16,000	$3,380, plus 40% of excess over $14,000.
Over $16,000 but not over $18,000	$4,180, plus 43% of excess over $16,000.
Over $18,000 but not over $20,000	$5,040, plus 46% of excess over $18,000.
Over $20,000 but not over $22,000	$5,960, plus 49% of excess over $20,000.
Over $22,000 but not over $26,000	$6,940, plus 52% of excess over $22,000.
Over $26,000 but not over $32,000	$9,020, plus 55% of excess over $26,000.
Over $32,000 but not over $38,000	$12,320, plus 58% of excess over $32,000.
Over $38,000 but not over $44,000	$15,800, plus 61% of excess over $38,000.
Over $44,000 but not over $50,000	$19,460, plus 63% of excess over $44,000.
Over $50,000 but not over $60,000	$23,240, plus 66% of excess over $50,000.
Over $60,000 but not over $70,000	$29,840, plus 69% of excess over $60,000.
Over $70,000 but not over $80,000	$36,740, plus 72% of excess over $70,000.
Over $80,000 but not over $90,000	$43,940, plus 75% of excess over $80,000.
Over $90,000 but not over $100,000	$51,440, plus 77% of excess over $90,000.
Over $100,000 but not over $150,000	$59,140, plus 79% of excess over $100,000.
Over $150,000 but not over $200,000	$98,640, plus 81% of excess over $150,000.
Over $200,000	$139,140, plus 82% of excess over $200,000.

31. INCOME TAX PAID AT SOURCE.—Enter 2 percent of interest on bonds on which Federal income tax was paid by debtor corporation.

32. FOREIGN TAX CREDIT.—If credit is claimed for taxes paid to a foreign country or possession of United States, submit Form 1116 and receipts for such payments. If credit is claimed for taxes accrued, attach to Form 1116 certified

$250 in the case of a single person and $500 in the case of a married person or head of a family. The determination of the taxpayer's status in the armed forces and his family status shall be made as of the end of the taxable year. Such personnel includes persons in the Marine Corps; the Coast Guard; the Army Nurse Corps, Female; the Women's Army Auxiliary Corps; the Navy Nurse Corps, Female; and the Women's Reserve Branch of the Naval Reserve; but does not include personnel in the inactive reserve or on retirement or members of the Army Specialist Corps. The amounts contributed by the Government to the servicemen's "monthly family allowance" are in the nature of gifts and need not be included in income.

I. DEPRECIATION, DEPLETION, AND AMORTIZATION OF EMERGENCY FACILITIES.—A reasonable allowance for exhaustion, wear and tear (including a reasonable allowance for obsolescence) (1) of property used in trade or business or (2) property held for the production of income, may be deducted, based on cost if acquired by purchase after February 28, 1913. If acquired before March 1, 1913, or otherwise than by purchase, see section 114.

For depletion deduction, see sections 23 (m) and 114.

Individuals, provided an election is made as prescribed in section 124 (b), are entitled to a deduction with respect to the amortization of the adjusted basis (for determining gain) of an emergency facility (as defined in section 124 (e)), based on a period of sixty months. A statement of the pertinent facts shall be filed with the taxpayer's return.

J. INFORMATION AT SOURCE.—Every person making payments of (1) interest, rents, commissions, or other fixed or determinable income of $500 or more during calendar year 1942 to an individual, partnership, or fiduciary, or (2) salary or wages of $500 or more to a single person or $1,200 or more to a married person shall make a return on Forms 1096 and 1099.

K. STOCK OWNED IN FOREIGN CORPORATIONS AND PERSONAL HOLDING COMPANIES.—If at any time during the year you owned directly or indirectly stock of a foreign corporation, or a personal holding company (section 501), attach a statement showing name and address of each such company and total number of shares of each class of outstanding stock owned. If at any time during the year you owned stock in a foreign personal holding company (section 331), include in income as a dividend the amount required by section 337, and if you owned 5 percent or more in value of the outstanding stock of such company, attach a statement giving in detail the information required by section 337(d).

SPECIFIC INSTRUCTIONS

(Numbered to correspond with item numbers on page 1 of return)

1. SALARIES, ETC.—Include compensation received as an officer or employee of a State or political subdivision or any agency or instrumentality thereof. (See General Instruction H3(h) for exclusion allowance for military and naval personnel.)

2. DIVIDENDS.—Enter total of all taxable dividends. Include dividends on share accounts in Federal savings and loan associations in case of shares issued on or after March 28, 1942; dividends on shares issued before that date should be entered in Schedule A.

3. and 4. INTEREST ON CORPORATION BONDS, ETC.—Enter in item 4 interest on bonds, debentures, notes, or certificates or other evidences of indebtedness, issued by any corporation with interest coupons or in registered form. Do not include interest on any such obligation which constitutes stock in trade of the taxpayer or any such obligation of a kind which would properly be included in the inventory of the taxpayer if on hand at the close of the taxable year, or any such obligation held by the taxpayer primarily for sale to customers in the ordinary course of his trade or business. Such interest should be entered in item 3. (See Instruction 5 for deduction of amortization of bond premium.)

5. INTEREST ON GOVERNMENT OBLIGATIONS, ETC.—Enter in Schedule A the amount owned at the end of the year of the various obligations listed therein and the interest received or accrued during the year. The total of column 5, line (h), Schedule A (amount subject to surtax only), should be entered as item 5 (a). Interest received or accrued during the year and reported in line (i), Schedule A (amount subject to normal tax and surtax), should be entered as item 5 (b).

Section 23 (v) provides for the deduction of amortizable bond premium by the owner of the bond. The term "bond" means any bond, debenture, note, or certificate or other evidence of indebtedness, issued by any corporation and bearing interest (including any like obligation issued by a government or political subdivision thereof), with interest coupons or in registered form, but does not include any such obligation which constitutes stock in trade of the taxpayer or any such obligation of a kind which would properly be included in the inventory of the taxpayer if on hand at the close of the taxable year, or any such obligation held by the taxpayer primarily for sale to customers in the ordinary course of his trade or business. The amount of the deduction, computed under section 125, should be entered in the appropriate spaces in items 4 and 5, and deducted from the amount of interest received or accrued.

Amortization of bond premium is mandatory with respect to fully tax-exempt bonds (the interest on which is not subject to income tax). In the case of fully taxable bonds (the interest on which is subject to the normal tax and the surtax) and partially tax-exempt bonds (the interest on which is subject only to surtax), the amortization of bond premium is elective as to either one or as to both. Such election shall be made by the taxpayer by taking a deduction for the bond premium on his return for the first taxable year to which he desires the election to be applicable. Attach a statement showing the computation of the deduction.

The election shall apply to all bonds with respect to which it was made owned by the taxpayer at the beginning of the first taxable year to which the election applies and also to all bonds of such class (or classes) thereafter acquired by him, and shall be binding for all subsequent taxable years, unless upon application by the taxpayer, the Commissioner permits the taxpayer to revoke the election.

In the case of a fully tax-exempt bond, the amortizable premium for the taxable year is an adjustment to the basis or adjusted basis of the bond, but no deduction is allowable on account of such amortizable premium. In the case of a fully taxable bond, the amortizable premium is both an adjustment to the basis or adjusted basis of the bond and also a deduction. In the case of a partially tax-exempt bond, the amortizable premium for the taxable year is used for three purposes; (1) as an adjustment to the basis or adjusted basis; (2) as a deduction; and (3) as a reduction to the credit for the interest on the bonds.

Noninterest-bearing obligations issued at a discount.—Taxpayer on the cash basis may elect, as to all noninterest-bearing obligations issued at a discount and redeemable for fixed amounts increasing at stated intervals (for example, United States Savings Bonds), to include the increase in redemption price applicable to the current year. For the year of election the total increase in redemption price of such obligations occurring between the date of acquisition and the end of the year must be included. Taxpayer so electing shall report such income as interest in item 3, 4, or 5, page 1, whichever is applicable, and attach statement listing obligations owned and computation of accrued income. An election exercised in the current year or in a prior year is binding for all subsequent years.

6. RENTS AND ROYALTIES.—Include rent received in property or crops. Report crops received on crop-share basis in year in which disposed of (unless return is made on accrual basis).

7. ANNUITIES.—Amounts received as an annuity under an annuity or endowment contract shall be included in gross income to the extent of 3 percent of the aggregate premiums or consideration paid for such annuity. If the aggregate of the amounts received and excluded from gross income in this and prior years equals the aggregate premiums or consideration paid for such annuity, the entire amount thereafter received must be included in gross income.

FOR INSTRUCTIONS 8, 9, AND 10, SEE PAGE 4

12. CONTRIBUTIONS PAID.—Enter (not to exceed 15 percent of your net income computed without the benefit of this deduction, or of the deduction for extraordinary medical expenses deductible under section 23 (x)) contributions or gifts, payment of which was made within the year to or for the use of—

(a) A corporation, trust, or community chest, fund, or foundation, created or organized in the United States or in any possession thereof or under the law of the United States or of any State or Territory or of any possession of the United States, organized and operated exclusively for religious, charitable, scientific, literary, or educational purposes, or for the prevention of cruelty to children or animals, no part of the net earnings of which inures to the benefit of any private shareholder or individual, and no substantial part of the activities of which is carrying on propaganda, or otherwise attempting, to influence legislation;

(b) The United States, any State, Territory, or any political subdivision thereof, or the District of Columbia, or any possession of the United States, for exclusively public purposes;

A. WHO MUST MAKE A RETURN.—Every citizen and resident of the United States having during the taxable year *gross income* (income derived from any source whatever, unless exempt from tax by law) in an amount specified below, *regardless of the amount of net income*, shall make a return if:

(1) *Single for entire year, or married and not living with husband or wife for any part of the taxable year.* If having a gross income of $500 or over.

(2) *Married and living with husband or wife for the entire taxable year.* If each has income and their combined gross income is $1,200 or over, they must each make a return or file a joint return. If only one has income and his gross income is $1,200 or over, only that one is required to make a return.

(3) *Married and living with husband or wife for only part of the taxable year.* If each has income and their combined gross income is $1,200 or over, or equal to, or in excess of, their total personal exemption (not including credit as head of a family or for dependents), they must each make a return or file a joint return. If only one has income and his gross income is $1,200 or over, or equal to, or in excess of, his personal exemption (not including credit as head of a family or for dependents), only that one is required to make a return. (See Specific Instruction 21 as to personal exemption.)

Joint return.—May be filed by husband and wife *only* if they are (1) both citizens or residents of the United States and (2) living together at the end of the taxable year. A joint return is permissible even though one has no gross income. In a joint return the aggregate income, deductions, and credits are computed as though husband and wife were one person.

Deceased individuals.—The return for the period to the date of death of a decedent is a return for a fractional part of a year, and the credit for personal exemption (as well as credit as head of a family and for dependents) is reduced proportionately to the number of months in such period. The return is required on Form 1040, not Form 1040A, and is required if gross income to date of death is equal to, or in excess of, the credit for personal exemption as so reduced. Amounts (other than amounts includible by a partner under section 182 in computing net income) which would be includible in the net income of, or allowable as deductions and credits to, a decedent solely by reason of his death shall not be included in computing the decedent's income for the taxable period in which falls the date of death. All amounts of gross income which are not includible in the income of the decedent will, when received, be includible in the income of the estate or person receiving such amounts by inheritance or survivorship from the decedent under section 126.

B. FORM OF RETURN.—Citizens and resident alien individuals use Form 1040, except that those whose gross income, computed on the cash basis for the calendar year, is not more than $3,000 and consists *wholly* of salary, wages, other compensation for personal services, dividends, interest, or annuities *may* use optional Form 1040A. In the case of a husband and wife living together at any time during the year, separate returns may not be made on Form 1040A unless each elects to use that form. Nonresident aliens use Form 1040B or 1040NB. Fiduciaries for estates and trusts use Form 1041.

C. FILING OF RETURNS AND PAYMENT OF TAX.—File on or before 15th day of 3d month following close of taxable year with collector for the district in which the taxpayer has his legal residence or principal place of business. If the taxpayer has no legal residence or place of business in United States, file with collector at Baltimore, Md. The taxpayer's home address must be given and a permanent business address may be added. Pay in cash at collector's office or by check or money order payable to "Collector of Internal Revenue." Pay in full with return or in four equal installments, on or before the 15th day of the 3d, 6th, 9th, and 12th month from close of taxable year.

D. TIME FOR PERFORMING CERTAIN ACTS POSTPONED BY REASON OF WAR.—Section 3804 (a) provides that any period of time after December 6, 1941, during which an individual is continuously outside the Americas for more than 90 days, and the next 90 days thereafter, shall be disregarded in making certain determinations under the internal revenue laws with respect to performance of certain listed acts. These acts include, among others, filing returns and making payments of income tax (with certain exceptions), filing claims for credit or refund of any tax, and assessing and collecting any tax.

In the case of an individual who is a prisoner of war or otherwise detained by an enemy country or by enemy forces or who is in the military or naval forces of the United States serving on sea duty or outside the continental United States, sections 13 and 14 of the Act approved March 7, 1942, specify as the due date for filing returns and making payments of income tax the fifteenth day of the third month following the month in which such status ceases or the present war is terminated, whichever is the earlier.

E. PENALTIES.—Severe penalties are imposed for failing to file a required return, for late filing, and for filing a false or fraudulent return.

F. DECLARATION.—The return shall contain or be verified by a written declaration that it is made under the penalties of perjury. The return may be made by an agent if the taxpayer is (1) too ill to make it or (2) absent from the United States for 60 days before the due date. A power of attorney on Form 935 or Form 936 (husband and wife) must accompany the return made by an agent. Person or persons actually preparing the return for the taxpayer must also sign the declaration.

G. RECEIVED OR ACCRUED INCOME.—If books are kept on accrual basis, report all income accrued, even though not received, and expenses incurred even though not paid. If books are not kept on accrual basis, or if no books are kept, report all income actually or constructively received, and all expenses paid.

H. ITEMS EXEMPT FROM TAX.—As to items of income exempt from tax other than those listed below, see sections 22 (b) and 116.

(1) Interest on governmental obligations is exempt to the extent indicated in Schedule A.

(2) **Proceeds of insurance policies.**—The proceeds of life insurance policies, paid by reason of the death of the insured, are exempt. If any part of the proceeds is held by the insurer under an agreement to pay interest, the interest is taxable. Amounts received under a life insurance or endowment policy, not payable by reason of the death of the insured, are not taxable until the aggregate of the amounts received exceeds the premiums or consideration paid for the policy. (See Specific Instruction 7 as to taxation of annuities.)

(3) **Miscellaneous items wholly exempt from tax:**

(*a*) Gifts (not received as a consideration for service rendered) and money and property acquired by bequest, devise, or inheritance (but income therefrom is taxable);

(*b*) Except in the case of amounts attributable to (and not in excess of) deductions allowed under section 23 (x) in any prior taxable year, amounts received through accident or health insurance or under workmen's compensation acts, as compensation for personal injuries or sickness plus the amount of any damages received, whether by suit or agreement, on account of such injuries or sickness, and amounts received as a pension, annuity, or similar allowance for personal injury or sickness resulting from active service in the armed forces of any country;

(*c*) The rental value of a dwelling house and appurtenances thereof furnished to a minister of the gospel as part of his compensation;

(*d*) Pensions and compensation received by veterans from the United States and pensions received from the United States by the family of a veteran, for services rendered by the veteran in time of war;

(*e*) Interest on adjusted service bonds and interest credited to postal savings accounts to the extent that they represent deposits made before March 1, 1941;

(*f*) Income, other than rent, derived by a lessor of real property upon the termination of a lease, representing the value of such property attributable to buildings erected or other improvements made by the lessee;

(*g*) Income attributable to the recovery during the taxable year of a bad debt, prior tax, or delinquency amount, to the extent that such debt, tax, or delinquency amount did not operate to reduce the income tax liability of the taxpayer for any prior year with respect to such debt, tax, or amount; and

(*h*) Amount received by personnel below the grade of commissioned officer in the military or naval forces of the United States as salary or compensation in any form from the United States for active service in such forces not in excess of

1. All other things being equal, does the shape of a vessel affect the design and selection of mixing equipment therefore? Yes, it does. For one instance, let us consider the case of a rectangular-shaped vessel. The regions of stagnation in such rectangular-shaped vessels as concerns mixing, which tend to develop in the vicinities of the side-to-side and bottom-to-sides joints will frequently demand, if the interests of uniform mixing are to be served, either or both of the following ameliorating measures:- a greater-than-normal intensity of work-input per unit volume of batch as a means toward reducing the degree of stagnation existing in the said joints; and/or a breaking-up of the required work input into a larger-than-normal number of individual mixing assemblies to assure a better distribution of the requisite mixing action. (NOTE:- "Greater-than-normal" and "larger-than-normal" are used here to describe procedures which are extraordinary as referred to "normal cylindrical vessel practice".). As a second instance, let us regard the case of extraordinary slender-shaped vessels, (i.e. by slender-shaped vessels, we mean vessels which are characterized by extremely large length-to-diameter ratios). The difficulties which attend end-to-end transmission of mixing action in slender-shaped vessels will either force resort to special multiple-rotor mixing assemblies (i.e. mixing assemblies in which a plurality of rotors are mounted on a common shaft for the purpose of establishing a tandem action between the individual rotors) or to the use of a larger-than-normal plurality of individually mounted mixing units employed at appropriate intervals along the end-to-end axis and at right angles to the said end-to-endaxis. The instances offered above are but two isolated ones to exhibit the influence of vessel-shape on mixing equipment design. Needless to say, others abound.

2. All other things being equal, will the use of dished, flat, or conical heads in cylindrical kettles affect the design and selection of mixing equipment therefore? Yes, the type of head used will determine, or at least affect, the solutionof the mixing problem. For one thing, the type of head used will determine whether there will exist a condition of stagnation, as concerns mixing, at the head to-cylinder joint and also the probable severity of the stagnation condition, if such there exists. Depending upon the type of mixer used, the type of head used would determine the measure/s adopted to counteract the stagnation condition existing in consequence of the head-to-cylinder joint. Secondly, where the type of mixing equipment used calls for the deflection of an impelled stream off the head member as is frequently the case where marine propeller types of agitators are employed, the type of head used will determine not only the character of the deflection, but secondarilly whether additional measures must be adopted to counteract any possible excessive loss of mixing action resulting from "impact losses".

3. Why do baffle structures, coils, internal ladders, etc. and badly-formed joints in kettles produce areas of stagnation as regards mixing? Reduced to essentials, mixing may be attributed to two basic phenomena, the mixing which is due to the direct action of the agitator assembly members (i.e. through impact with the agitator members and/or through

frictional impedance to flow offered by the said agitator members and al structures); and, secondly, the mixing which occurs in consequence of the kinetic energy (energy of motion) imparted to an impelled stream of liqu Coils, internal ladders, sharp corner-joints, etc. and, indeed, any mem which will induce sharp changes in the velocity of an impelled stream of liquid will, by materially reducing the kinetic energy of the said strea reduce the amount of mixing work of which the moving stream is potentiall capable. Where the impeding structure, member, shape, etc. is capable o either drastically or completely reducing the kinetic energy of the impelled stream, there results a zone of stagnation.

4. Why is it important to know the pressure level at which the kettle is operated in designing the mixing equipment? It is important to know the maximum pressure at which a mixing kettle is operated (i.e. the maximum positive and/or vacuum pressure) for the following two reasons:- firstly, in order to be able to determine the resultant thrust load acting on the agitator Drive bearings; and, secondly, in order to determine the type and size of stuffing box which should be employed to prevent leakage at the point/s of shaft entry into the mixing vessel. The resultant thrust load acting on the agitator Drive bearings have three basic components:- the dead-weight thrust of the agitator shaft, the agitator proper, etc.; whatever axial thrust is developed in consequ of the agitator's operation; and, lastly, the end-thrust acting on the s in consequence of any difference in pressure levels which may exist betw the interior of the vessel in which the shaft operates and the external atmospheric pressure. Any one of the mentioned component forces compris the resultant thrust load may, for certain instances, be equal to zero. Thus, for purely horizontal mixer units (such as side-entering agitator assemblies), the dead-weight axial thrust would be zero, the dead-weight of the assembly constituting in this case a component of the radial load of the agitator assembly bearings. As for the axial thrust which some types of agitators develop in consequence of their operation, this pheno is significantly characteristic only of agitators of the following types marine propellers, single-suction turbines, pitched-blade turbine mixers and paddle, anchor, or gate assemblies in which the blade components thereof are pitched to exercise a partial propelling action. For all ot types of agitators, the axial thrust developed in consequence of the rot operation would be virtually equal to zero. Considering the end-thrust acting on an agitator shaft resulting from differences in pressure level inside and outside the kettle in which the agitator assembly is located, it is obvious that when the internal operating pressure is atmospheric t said end-thrust would be equal to zero. The end-thrust resulting from a difference in pressure levels inside and outside the mixing kettle assemb may be computed by the formula:-

$$(A)(P)$$

Where A is the cross-sectional area of the agitator shaft in sq. ins., wh P is the difference between the internal operating pressure and atmosphe pressure, and where an agitator shaft of uniform diameter is being dealt with. If P is positive, then the said end-thrust would be outward from vessel; while if P is negative (i.e. if the internal operating pressure either a partial or complete vacuum), the end-thrust due to pressure wou inward to the vessel. It will furthermore be noted that not only is it important to know the internal operating pressure of a kettle in order t a proper stuffing box be selected and in order that a proper computation

the thrust loads as described above be arrived at, but also for the purpose of determining adequate seals for such sealed submerged bearings or guides as may be employed in special instances.

5. Why is it important to know the maximum operating temperature for the liquid batch in a mixing problem in order to properly design and select mixing equipment? The reasons which may be properly advanced in this regard are quite numerous and widespread. Some few of the more important of these are listed below:-

   1. because of the bearing of temperature upon the corrosion resistance properties of the materials of which the submerged members of the agitator assembly may be built

   2. because of the bearing of temperature upon the strength properties of certain materials of which the agitator assembly may be built

   3. because of the bearing of temperature upon the clearances specified in such guide members as may be used

   4. because of the bearing of temperature upon the allowable unit bearing pressure which may be used in designing the agitator shaft bearing and guide members

   5. because the maximum operating temperature will determine whether the stuffing box unit, if any is used, should be jacketed or not

   6. because, in certain extraordinary operating temperature conditions, it is advisable to check on the amount of heat which may be transmitted through the shaft of the mixing assembly to the Drive itself

6. Why is it important to know the minimum operating temperature for the liquid batch in a mixing problem, if refrigerationis employed for the kettle and its contents, in order to properly design and select mixing equipment? Here, as in Item #5 above, the possible reasons to support the importance of knowing the minimum temperature level employed as the questionrange over a wide scope. However, the most important of these reasons is the bearing of exceptionally low temperatures on the strength properties of the various members of the agitator assembly. Many, or even most, of the common materials of fabrication entering into the design of agitators demonstrate a marked tendency to develop embrittlement; poor resistance to abrasion, and generally reduced strength properties at temperatures significantly below the freezing point of water.

7. Is it important to know whether an agitator assembly is to enter through a jacket? Yes, it is. It is not only important for the person selecting and designing the mixing equipment not only to be acquainted with the fact that it is proposed to bring the mixing assembly (i.e. the shaft thereof) in through a kettle jacket but also to know the extreme temperature service/s for which the jacket is intended. Merely being informed of the intention to bring the mixing equipment through a jacket would

of course c[illegible]ion the means thereby the [illegible]xing equipment, and particularly its Drive, would b mounted, while familiarity with the extreme temperature service/s for which the jacket is intended would permit the most intelligent selection of the packing material/s and guide-bushing material components of any stuffing box which might be employed. In extraordinary temperature service conditions, knowledge of the specific temperature range might well affect the specification for the Drive and the means adopted for lubricating such outboard shaft-bearings as are involved, and could even possibly necessitate forced lubrication and/or special cooling arrangements for the stuffing box assembly if a box were used at the point of shaft-entry through the jacket.

8. In physically blending two or more liquids, what is the function of mixing equipment? To answer this question, it is firstly necessary to define our terms. By "physically blending" liquids, we refer to any operation calling for the mutual dispersion in one another of two or more either partially or completely miscible liquids. By way of further clarifying what we mean by "physically blending" liquids, it should be noted that where the liquids to be blended are only partially miscible with one another the mixture is held to be a "blend" only when the ingredients of the mixture are present to the degree in which they are miscible with one another. If partially miscible components of a mixture are being dispersed in one another to an extent greater than the limit of their miscibility, the mixture as a whole goes out of the classification of a "blend" and into the realm of an emulsion, regardless of whether the resultant emulsion is of the permanent or temporary type. In a "blend", the dispersion of one liquid in another is said to take place to "molecular dimensions". That is to say, if it were possible to place a sample of the "blend" under a "molecular microscope", the molecules of the individual liquid components of the mixture would be found to be in symmetric arrangement in all planes with respect to one another. Mixing equipment as known today, regardless of make or type can obviously not be said to achieve the molecule-from-molecule disintegration of any single component of a liquid mixture which would underlie the afore-mentioned "dispersion to molecular dimensions". The molecule-from-molecule disintegration which of necessity must be attained to achieve truly molecular dispersion is, in fact, established through the means of the diffusion currents which are set up when mutually miscible materials are brought into contact with one another. The actual disintegration, as referred to above, takes place, in the primary instance, as a result of a mutual physical and/or physico-chemical neutralization of the molecular bonds or forces of cohesion which bind the molecules of the pure liquid together. The function of mixing equipment, in view of the above, is to establish the primary dispersion of one liquid in another as a means of bringing the "neutralizing" phenomena into being.

9. In view of the material in Question #8 above, how far are we truly privileged to go in setting forth efficiency claims for mixing equipment of one type or make or another as far as physical blending problems are concerned? Basic factors may be said to govern the efficiency of blending operations as defined above:- firstly, the uniformity of the mixing action; and, to a varying degree, the intensity of the means of agitation employed as measured in terms of horsepower input per unit volume of mixture. By the uniformity of mixing action,

we measure primarily to the degree to which the liquid batch is uniformly kept in a state of circulation and the degree to which all portions of the liquid batch are brought at one time or another within the scope of the direct action of the mixing units proper:---to the degree to which areas of stagnation or secondary zones of mixing inte are eliminated. The second of the factors which was mentioned above in connection with determining the efficiency of a blending operation, namely the effect of various intensities of work-inpur, is one which varies in importance depending upon the following factors:-

1. it will vary with the proportions in which the various compone of a mixture are blended

2. it will vary from case to case with the degree to which the components of the "blend" differ from one another in specific gravity, viscosity, and set

3. it will vary frequently not only with the means whereby the components are added to one another, but with the rate and or of addition as well

4. it will vary with the temperature of the "blend" as a whole

From the above considerations, the following guiding rules as regards the extension of efficiency claims may be deduced:-

1. Only to the extent that one mixing assembly arrangement assure a more clearly uniform distribution of the mixing action requi than another is it valid to set forth claims of greater effici for one assembly than another

2. Where a uniform distribution of mixing action exists, only to extent that the "blend" problem is responsive to additional r of work-input then only to the extent that one mixing assembly employs a greater work-input rate than another will one prove more efficient than another

3. Where relatively equally uniform distribution of mixing action exists for either of two competitive mixing assemblies, only to the extent that ready miscibility and/or ready diffusibilit of the components in one another is absent as a characteristic of the "blend" then only to that extent may we expect the rate of blending to be responsive markedly either to moderate incre in rates of work-input over an existing mixing assembly or to g increases in intensity of work-input over a certain minimum intensity of work-input

10. What is the role of mixing in promoting reactions? The crux of establishing maximum reaction velocities for all types of chemical reactions, regardless of the branch of chemistry to which they may belong, resides in the ability with which "molecular contact" and/or "ionic contact" and/or "atomic contact" is established. This does mean that in all cases the reaction will proceed as rapidly as the required level of "contact" is achieved. Indeed, there are some

reactions which are characterized by long induction-periods during w the reaction seems to hang fire despite the fact that the required level of contact has been established. There are furthermore some reactions which are innately slow reactions, in which case much or ev the bulk, of the reactants present remain for long periods of time in the required condition of "contact" in a completely unreacted state. Nevertheless, it is still true that the most immediate establishment of a certain minimum level of contact is a good overall rule for the establishment of maximum rates of reaction. This is so for the reaso that while rapid reactions would immediately proceed as a function of the facility with which "contact" is achieved, reactions characterize by induction periods and/or by innate slowness tend to respond as wel to the extent to which "contact" is established. In the latter types reactions, it is a known fact that while the most immediate achieveme of a state of "contact" would seem to merely constitute the building-up of a needless "reservoir" of unreacted materials, the presence of such unreacted materials as a sort of "reservoir" tends to set up a "reaction-potential" (comparable to voltage in electricity or pressur in fluid mechanics) which acts to:-

1. in the case of a reaction having an induction-period, shorten the duration of the induction-period and/or establish a more rapid reaction once the reaction begins

2. in the case of naturally slow reactions, establish a greater rate of reaction than would otherwise be possible.

The role of mixing in liquid reaction systems is to assist or make possible the earliest attainment of the required state of "contact". The mechanics whereby the condition of "contact" is achieved, and the precise role fulfilled by the mixing equipment, depends upon whether the reaction-system is a homogeneous one or a heterogeneous one. In homogeneous reaction-system since the establishment of "contact" may ultimately be reduced to the miscibilities and/or solubilities of one reactant with or in another, the mechanics, as referred to above, of establishing "contact" is wholly similar to the means whereby "blendi as treated in Item 8, is attained; and the role assumed by the mixing equipment then is completely comparable to that which mixing equipmen plays in simple physical blending operations. In instances of hetero geneous reaction systems, the role of mixing equipment differs from i function in homogeneous systems to the extent that the mechanics of establishing "contact" differs. Instead of ##########

NOTES:-

1. A homogeneous reaction system is one in which any or all of the components of the reaction mixture go into dispersion in one another to the full amount present to "molecular dimensions", as described under Item 8, in their unreacted form, the more or less casual and random mutual interpenetration by each other of the components of a homogeneous system, all exchanges and transfers o material taking place in the case of heterogeneous systems occur

exclusively at a well-defined interface zone between the continuous and discontinuous phases. The conditions whereby "contact" is attained in heterogeneous systems differ from those in homogeneous systems in the following additional respect. While the level of dispersion which a homogeneous system attains tends to be maintained at least at the level attained if the mixing operation is interrupted, a heterogeneous system will, upon cessation of mixing, recede to a less level of dispersion unless stabilizing materials are present or are added (i.e. that is to say, the particles of the discontinuous phase will, unless stablizers are present, tend to agglomerate, thus reducing the extent of the interface zone mentioned above). The role of mixing equipment, then, in agitating heterogeneous systems is, generally speaking, a far more important one than in the case of homogeneous systems. The said role may be said to consist of:- firstly, setting the maximum possible interface between the continuous and discontinuous phases; and, secondly, the task of maintaining the said maximum level of dispersion against the innate tendency of the discontinuous phase to come out of the said maximum level of dispersion. To the aforementioned tasks of mixing equipment in handling heterogeneous reaction mixtures there may, in some cases, be added the function of continuously "bruising" the surfaces of the particles of the discontinuous phase, not primarily for the purpose of further reducing the particles in size but to destroy "chemically stagnant films" which may tend to envelop the particles.

11. In view of the material in Item 10, how far are we truly privileged to go in setting forth efficiency claims for mixing equipment of one type or another as far the agitation of reaction mixtures is concerned? Claims as to probable improvement in reaction velocity which one type of mixing equipment might produce as compared with another may, indeed only be on the basis of direct experience with the reaction in question. Several reasons underlie this statement:-

    1. the reaction which it is proposed up through the use of one type of a mixer over another may be characterized by a long induction-period, in which case neither improvement in the distribution of the mixing action provided nor increases in the intensity of the mixing action nor changes in the specific actions whereby mixing is accomplished may appreciable affect the overall velocity of the reaction

    2. the reaction which it is proposed that we speed up through the use of "specially adapted" mixing equipment might conceivably belong to that class of reactions which are inherently slow, and which might therefore demonstrate a negligible responsiveness to improvements of the conditions under which the time in which "contact" is established

    3. of all the conditions under which reactions may transpire, temperature, and/or pressure, and/or agitation, it may be said as a general though not universally true rule, increases in intensity and improvements in the quality of mixing above a certain modicum thereof produces no results comparable to the influence of increases in temperature for almost all reactions or pressure in some reactions.

These comments are not, however, to be construed to establish an axio that mixing as such does not play an important part in promoting reactions and in establishing them at their maximum velocity. What t above remarks are intended to convey is an attitude of caution in proffering assurances as to the probable accelerating influences of one type of mixer over another in promoting chemical reactions. It should be noted in this regard that the fundamental proof of the atti advanced above are the following:-

1. in all chemical reactions, there exists an energy balance between the starting reactants and the resulting products. That balance establishes all of the characteristics of the reaction, including its velocity. If the said energy balan is reduced to its minimum terms, it may be said that each material which enters the reaction, or rather the ultimate constituents of which the material is composed---molecules atoms, or ions, are endowed with a certain amount of energy under the conditions in which the reaction transpires. The energy which these ultimate particles possess determines it "reactiveness", in the main

2. obviously, a gross piece of equipment like a mixer, which, pointed out above, merely acts as an auxiliary means to the processes of diffusion and solution whereby "ultimate conta is achieved and which does not directly the ability to separate molecule-from-molecule, etc. cannot reasonably expected to appreciably affect the energy potential of the "ultimate particles" (ions, or atoms, or molecules) upon whose behavior the characteristics of the reaction depends the main

But as noted above, if mixing equipment cannot extend a reaction's velocity beyond its own innate limit and yet can be employed to establish the reaction's maximum velocity limit, what are the factors which may restrict a reaction below its natural maximum velocity and does mixing equipment alter or affect the said factors? The factors may tend to restrict may be any one or any combination of the followi non-uniform distribution of the mixing action which is provided; and/ a lower than required intensity of work input; and/or an improper typ of mixing action. A non-uniform distribution of mixing action may result in any of the following undesirable conditions:- local undistributed pockets of reactants; and/or, in certain instances, as uneven transfer of heat from heat exchang surfaces to or from the reaction mixture; a protracted time cycle before "contact" is established on as complete a basis as is required for best results. lower than required intensity of mixing action willmaterially reduce rate of heat transfer to or from the reaction mixture and/or increase the time cycle required to establish that minimum level of "contact" is required in order that the reaction start up. Before we can trea with the effects which issue from an improper character of mixing act we must define what we mean by the terms, improper character of mixi action. Included in the "character of a mixing action" are the ratio in which the mixer exerts direct mechanical action on the reaction mixture to the extent to which it exerts indirect or secondary actio

on the mixture and the specific direction/s of flow which the mixer induces for the reaction mixture. The element of direct mechanical a which the mixer bring to bear on each portion of the reaction charge becomes a very significant factor:-

1. where materials are present in the reaction mixture which demonstrate, in the case of potentially homogeneous react mixtures (i.e. homogeneous from the standpoint of the reactants rather than products of the reaction), poor diffusibility and high viscosity or consistency

2. where solids are present as reactants and are added in large lump-size particles

3. where materials intended for solution in another reactant or reaction-vehicle tend to go through various stages of consistency upon solvent-infiltration prior to final solution and where the period of existence of the intermediate stages of consistency may be shortened by di mechanical action on the given solvent-infiltrated mater

In some very extraordinary cases, the absence or near-absence of appreciable direct mechanical action by mixing equipment is demande This latter condition has been known to prevail where materials of giant-molecular structure, as with the instance of the Vitamin B complex, are being reached, in which case direct mechanical action would tend to break the material down. Again, in cases where delic or tender catalysts are present in the reaction mixture and/or where surface-bruising of a catalyst cannot be permitted, the absence of direct mechanical action by the mixer unit proper is essential. The second component factor in determining the "character" of the mixin action provided, namely that of the directions/s of flow which are induced by the mixing unit, is employed as a counter-measure against the following conditions and phenomena where these are contended wi

1. the tendency of certain solids, gums, etc. to float on th surface of a liquid mass

2. the tendency of certain solids, gums, etc. to settle

3. the tendency of certain mixtures of liquids to "layer ou or to persist in a condition of stratification

4. the tendency of certain structures or structural formatio to produce areas of stagnation as regards mixing

5. the tendency of gases, in gas-liquid reactions, to escape before the gas-bubbles have been sufficiently reacted

The adopting of specific "directionalizing" of the streams which the mixer induces is also frequently resorted to with respect to heat transfer surfaces in order to establish an optimum condition for heat transfer. In this connection, it is wellto note that "directionali as produced by mixers is sometimes aided, as a design condition, by addition of special "directive" baffles and/or draft-tubes (SEE SEC ON DRAFT-TUBES IN THIS MANUAL). In summary,

1. ixing equipment regardless f type or make cannot extend a reactio 's velocity sig ificantly beyond its own natural spe d

2. efficient mixi g equipment can, however, establish the conditions whereby the reaction's maximum natural velo is realized. Attaining the abovementioned required co itions includes:- providing for a uniform distribution of mixing action; providing for at least the minimum required intensity of work-input; and, l stly, providi a mixing action of suitable character

3. the section above dealing with "blending operations" will provide a guide for estimating the relative weigh and importances of mixing intensity, mixing uniformity and mixing "character" as regards homogeneous reaction systems; while the sections below treating with emulsi and suspensions willprovide similar guides in re heterogeneous reaction systems

12. What role does mixing equipment assume in the preparation of emulsio
Before dealing specifically with the function of mixing equipment in preparing emulsions, we should define what we mea by the term, emul An emulsion is a dispersion of one or more liquids as an immiscible phase in another liquid or mixture of liquids. Either the dispersed (discontinuous) phase or the continuous phase may co tain a solid/s in a state of solution or s spension. Emulsions may furthermore be of either of two types:- temporary emulsions, on the one hand; or, perm nent emulsions, on the other. Temporary emulsions are tho in which it is not desired, for one reason or another, that the stability of the dispersion c ntinur appreciably beyond the immediat period of mixing or emulsification action. Permanent emulsions are those in which the stability of the dispersion is required to endure for an indefinite period beyond the immediate emulsification actionl Temporary emulsions are most frequently met with:- in washing or scrubbing operations in the purification of gases, liquids, or solic in heterogeneous reaction systems as described above; and as intermediate steps in operations involving the transfer of solids, liquids, or gases which are in solution, , in one liquid to another liquid. The discontinuous phase of an emulsion wi most usually consist of particles of fairly uniform dimensions. The precise dimensions of the said particles will vary with the emulsion in question and, frequently, with the procedures employed in the prep ation of the emulsion; but, taking the range of emulsions as a whole may lie anywheres in the range between particles of 1/8" mean diamet to 1 or 2 microns. In general, it willbe found that the question of stability of emulsions is one which is very rigorously associated with the particle-size to which the discontinuous phase is dispersed What factors, the, control the particle-size which is achieved for the discontinuous phase? These will be found to be:-

1. the colloid, if any, present in the emulsion-formulati

2. the order and rate of addition of the components of th formulation

3. the nature of the mixing action employed

Before considering each of these factors in particular, it should b added that the relative importance of each varies with the emulsion at hand. Dealing with the question of stabilizing colloids firstly these will be found to consist most usually of organic or metallo-organic materials or mixtures which, in any case at hand, is insolu in both phases of the emulsion, or at least in the continuous phase The colloid may be an added component of the emulsion-mixture as s or it might be a natural component of one of the ingredients of the emulsion mixture. The purpose of the colloid, where one is present is to provide an envelope for each of the particles of the disperse phase, the said envelope serving as a surface capable of collectin and retaining the electrostatic surface-charges which are generate and deposited on the said envelope in consequence of the mixing action provided. The condition of continued dispersion, or stabilit of the emulsion, which is attained for any emulsion is a function of the mutual repulsion by each other of the envelope-coated partic the said condition of mutual repulsion being established in consequ of the deposit of surface-charges of like sign on each colloid envel The ability of any given eligible colloidal material to satisfy the stability-requirements of an emulsion problem at hand will frequent be found to be specific not only to the chemical composition of the emulsion as such but for the temperature and pH conditions which exist during emulsification. Just how important the use of the proper type of colloid is will be demonstrated by the fact that changes in the colloid used will be frequently make possible and/or necessary changes in the type of mixing equipment used in order to obtain set levels of dispersion and stability. The importance of the order and rate of addition of the components of an emulsion formulation is one which can vary from insignificant proportions in some cases to outstanding proportions in another. In certain instances, the ability to achieve any set level of stability will depend upon the most meticulous adherence to a certain order and/or rate of addition of components, all other procedures in those cases resulting in adverse effects. The functions served by the mixing equipment, after the interplay of the abovementioned factors have been pointed out, must be understood against the following backgrou As opposed to mixtures which form true solutions (or dispersions to molecular dimensions) and, hence, mixtures which could be brought to homogeneity through the mechanics of diffusion currents acting themselves providing a sufficient amount of time where allowed to elapse subsequent to the full "compounding" of the mixture, emulsio mixtures can be established at even the most elementary levels of dispersion only thru the application of mechanical or external sources of work to the emulsion-mixture. The external work which is applie to an emulsion system goes, firstly, to the dispersion or physical disintegration of the discontinuous phase, and, secondly, to deposi and generate the surface-charges on the discontinuous phase to whic reference is made above. Of these tasks which the mixing equipment must accomplish, the distribution of the discontinuous phase is, ge erally speaking, the less critical. The generation and deposition the surface-charges, where it is required (i.e. where prolonged sta of the emulsion is desired), presents a far more complex demand in that while in some cases the slightest exceeding of even the most gentle intensities of work-application will result in an "over-work or "over-shearing" of the emulsion in other cases the slightest falling short of a certain minimum intensity of work-input will re in an inability to produce the required level of stability. In oth cases, the allowable range of work-intensities which may be applie

will be found to be virtually limitless or will run between wide limits. The ability of the discontinuous phase to accept a requi surface-charging will frequently be responsive as well to the "character" of the mixing action employed. All other things being equal, then, we may draw the following generalizations in re the function of mixing equipment in emulsification problems:-

1. for a piece of mixing equipment to be suited to an emulsification problem, it must not only be capable of accomplishing the task of dispersing, but, if enduring stability of the produced emulsion is a requirement, it must employ or exert an intensity and "character" of work-input which is adapted admirably to the generation and deposition of surface-charges on the particles of the dispersed phase

2. if the emulsion to be produced is of the temporary type (and, it should be added, does not even involve a stable stage of the emulsion as an intermediate step), then the deposition of surface-charges, as explained above, does not enter as a factor. In such cases, there will exist no critical level of work-input intensity, and hence, the sole considerations in determining the required rate of work-input would be:- the size of the batch of emulsion to be prepared; the maximum viscosity assumed by the emulsion system during its preparation; the specific gravity of the emulsion; the period of time to be allowed for attainment of the emulsified state; and the requirements of the emulsification kettle for uniform distribution of the mixing action

3. if the emulsion to be produced is to be of the permanent or stable type, the limits as to work-intensity which the mixing equipment may exert, and the "character" of mixing action used, will be conditioned by the type of colloid present and/or by the order and rate of addition of the components of the emulsion

13. <u>In view of the material discussed under Item12, what claims as to the probable emulsfication efficiency of a mixer of one type or make or another may be honestly advanced?</u> Without specific knowledge of the type of mixer which has been successfully employed in preparing the emulsion in question, at least on a laboratory or pilot plant scale, all claims as to probable efficiency of onetype of mixer oranother would be inclined to partake of an extremely dubious if not a somewhat spurious character. It is obvious that where, as noted above, there may exist minimum and/or maximum limits as to the work-intensities which may be applied to any emulsion formulation at hand and where both the latitudes as to the "character" of the mixing action applied and the work-intensities applied may extremely limit all pre-estimates as to probable efficiency of emulsification equipment would be nebulous. This is especially true in view of the highly empirical character of the field and the absence of any but the most general rules regarding the mixing requirements of a proposed emulsion. Unless the emulsion in question is of the temporary type, in which case it may be treated as any run-of-the-mill mixing problem since no problems of enduring stability are involved, the sole basis of an

estimate as to the probable efficiency of a piece of mixing equipme in an emulsification problem must be direct experimental evidence with the proposed piece of equipment or related equipment. Extendi the thought implied in the aforegiven sentence and, in a sense, civ its proof or evidence of its validity, the following statements, based upon direct experience in the field of emulsification, will be in point:-

1. while some emulsions, as formulated in composition and preparation procedures, may be produced by normal mixing equipment as employed in the liquid mixing field, others wil resist formation with equipment offering a "character" and intensity of action differing appreciably from the mo intense form of milling equipment

2. some emulsions which are presently being produced on a "barrel-and-stick" basis must on the other hand be subject to a "character" and intensity of mixingaction not appreci different if the desired qualities of the emulsion are to retained

3. if an emulsion which is currently being prepared on labor or pilot scale is to be transferred to commercial scale production or, if larger equipment than is currently used contemplated, one may choose between retaining in the new equipment the closest approximation of previously-employe equipment in "character" and in intensity of work-input o embark upon an experimental program to determine the work- input "specifications" of the emulsion at hand. This does not mean that the designer cannot permit any deviations from the original conditions under which the emulsion at hand was prepared nor that he is restricted to the most pr cise and detail duplication of the originally-employed equipment, since the broad classification of equipment to which the originally-employed emulsifier may be assigned wi most usually contain allied equipment in both "character" intensity of action. Indeed, other equipment belonging to some classification may, where "magnification" of producti is contemplated, offer more complete answers to the proble of equipment with enlarged capacities. Thus, where enlarg replicas of the originally-employed equipment also entail concommitant magnification of inefficiencies (as to distrib of mixing action and the like) of the original type of equipment, equipment of an allied type but excluding the u desirable features of the original equipment may safely be employed. For the sake of these considerations, it should noted that all known forms of emulsification equipment may be safely divided into three classification:- firstly, equipment involving plate-to-plate shearing action or rely upon members-in-contact having speed differentials in the absolute or relative sense; secondly, equipment combining

high rates of liquid circulation with stator-to-rotor relationships between the component members of the agitator assembly proper, but where the stators and rotors cannot be placed in the "direct" contact class as is the case with the milling type of equipment dealt with first and, finally, equipment employing as its main component of action, and its sole component, the circulation, whether high rate or not, of liquid and the secondary effects resulting therefrom.

In summary, in order to reasonably estimate the probable efficiency of a certain type of mixing unit as a piece of emulsification equipment the following data forms a minimum basis for such consideration: the type of emulsion to be prepared (i.e. whether of the permanent or temporary type); the type of equipment on which it was previously successfully prepared regardless of the scale previously employed and the intensity, in terms of horsepower expended per unit of volumeof finished emulsion, which was previously used. No other basis, other than that just set forth, will suffice. It goes without saying however that comparisions as to probable of efficiecies of any two or more mixing assemblies as emulsification equipment in which the correction of a condition of uneven distribution of mixing action enters as the main consideration is a safe and scientifically valid one providing the correction of the said condition envisions no appreciable changes in the intensity and "character" of the prevailing mixing action. Finally, where an emulsification problem encompasses two divisible operations, to wit a pre-mixing or pre-emulsification action as a preliminary step to a final emulsification operation, where each of the steps is carried out in different types of equipment each of the steps may be properly considered as integral problems in the light of the above discussion and may be so treated from the standpoint of equipment selection.

14. <u>What function does mixing equipment perform in the preparation of and/or maintaining of suspensions?</u> A suspension is a dispersion of a solid or mixture of solids as an undissolved phase in a liquid or mixture of liquids. Suspensions, like emulsions, may be of either of two types:- either of the temporary type; or, of the permanent type. Suspensions of the permanent type have all the characteristics of formation or preparation which are common to emulsions of the corresponding type, and, likewise, involve the presence in the suspension-formulation of colloids. Hence all of the material discussed above in connection with emulsions of the permanent type may be applied, with scientific correctness, to the problem of permanent type suspensions and their production. In passing, it would be well to note that the colloids which are used in the preparation of suspensions are frequently referred to as "wetting agents". The problem of preparing suspensions will, however, be found to differ from that of preparing emulsions in some respects, regardless of the type in question. As in the case of emulsions, particle-size to which the dispersed phase is distributed will vary, to a greater or lesser degree, with each suspension at hand, and, will frequently vary in response to changes in the procedures of preparation. Taking the range of suspensions as a whole, the

particle-size[illegible] which the dispersed pha[illegible] is distributed may vary anywheres fro[illegible]1 or 2 microns as a limit[illegible] particles having a mean dimension in excess of 1" as an upper limit, with suspensions of the permanent type being characterized by particle-sizes lying within a range running from 1 micron to 15 microns. Extending the analogous circumstances underlying the basic phenomena whereby emulsions and suspensions are brought into being, it will be found that the external work which is applied to a suspension formulation bears the same degree of essentiality to the attainment of the required level of dispersion as is the case with emulsions; and, where permanent type suspensions are involved, the said external work-input does not only to accomplish the physical disintegration of the solids-phase but, as in the case of permanent emulsions, goes as well to generate and deposit upon the colloid agent envelopes the electrostatic surface-charges upon which the stability of the suspension is predicated. While the conditions surrounding the said generation and deposition surface-charges in the case of suspensions is frequently as critically responsive to certain limiting intensities of work-input and/or to certain preparation procedures and/or to certain specific colloidal agents as in the case of emulsions, the problem of accomplishing the physical disintegration of the added solids will be found to be more specifically tied to certain "characters" of mixingaction than is the case with emulsions. As would be normal to expect in view of the fact that the forces of cohesion between the molecules or atoms or ions (as the case may be) of a solid are stronger than the cohesive bonds tying the ultimate corresponding entities of a liquid, the case with which the physical disintegration of the added solids is effected will respond very closely, despite the aiding or delaying effects of certain colloids or "wetting agents", to the degree to which the mixer equipment employed exerts a direct mechanical action. This is especially true of those instances where temporary emulsions are being prepared and hence where colloids or "wetting agents" are not involved.

15. In view of the material in Item 14, what claims as to the probable efficiency in the preparation of suspensions can be honestly put forward for mixersof one type or make or another? As in the case of the corresponding query in re the question of emulsions, this question must be answered under two titles:- irstly, as regards temporary suspensions and, the, as regards permanent suspensions. Considering the cases of temporary and permanent suspensions jointly as far as generalizations covering both will go, it is important to note that short of:-

1. direct experience with the suspension at hand with the proposed piece of mixing equipment and under the identical production procedures

2. evidence based upon the performance of equipment of allied nature to the type being proposed and under the identical production procedures

there exists no basis whatsoever for extending assurances as to the probable mean particle-size in the dispersed phase which will be obtained. Estimates as to the probable comparative but not specific performance of mixing equipment in setting up temporary suspensions

however, be made on the basis of the comparative degree to which the piece of mixing equipment at hand exerts direct mechanical action on each portion of the formulation charge, since the complicating factor of limiting intensities of work-input and its relationship to the stability of the produced suspension does not
Comparative performance estimates of newly proposed equipment in the case of emulsions of the corresponding type (SEE ITEM 13). As in the case of emulsions, instances in which the preparation of a suspension involves a pre-mixing operation as a preliminary step to final preparation of the suspension at hand and where separate pieces of equipment are employed in carrying out each step involve individual treatment and consideration of each step in accordance with the discussion given above.

16. What role does mixing play in the preparation of solutions? The phenomenon of preparing solutions calls for the dispersion to molecular, ionic, etc. (as the case may be) dimensions of a solid or mixture of solids in a liquid or mixture of liquids. In true solutions, as opposed to suspensions, the destriction of the solids-structure, the disintegration of the solid/s, not only involves a reduction of the solid/s to more ultimate dimensions than is the case with suspensions the process as well of destruction as well relegates the direct mechanical action which a mixer may bring to bear to an auxiliary rather than prime role, since the actual reduction of the solids of solution to its ultimate dimensions is accomplished through the neutralizing by the liquids/s of the phhsico-chemical bonds which account for the integration of the ultimate component particles of the solute into a material of solids consistency. This statement is not intended to play down the functions performed by mixing equipment in preparing solutions but rather to place the various actions which mixing equipment is capable of bringing to bear in a proper relationship to the main mechanics of dissolving action. In what ways, then, do the actions which a mixer is capbale of exerting affect the said main mechanics dissolving? The two main components of any mixer's actions are:- firstly the inducing of flow for all or some portion of a kettle's contents the attainment thereby of some measure of turbulence; and, secondly, direct mechanical influence upon the portion/s of the charge with which the mixer is brought into direct contact. The function of the condition of turbulence is to provide for a continuous renewal of the solvent-of-contact with the solute and thereby to relieve any tendency towards an inhibited rate of solution which might otherwise arise from a condition of localized saturation or near-saturation of the solvent-of-contact. The service performed by the direct mechanical action which a mixer affords serves to tend to mechanically reduce the size of the solute particles and hence to open a minimum area of contact solute to the solvent phase.

15. In view of the material in Item14, what claims as to dissolving efficiency may be honestly advanced for a mixer of one type or make or another? Boiled down to its essentials, the role of mixing in preparing solutions is largely comparable to the role of mixing in promoting chemical reactions. That is to say, the proper intensity, distribution, and "character" of mixing action can establish the solution velocity of any case at hand at its own inherent maximum level but it cannot extend the said velocity beyond its own inherent

maximum level. The inherent maximum solution velocity, looking over the field of solutions as a whole, may vary from infinitesimal dimensions to infinite dimensions, with nothing except direct experience with any particular case at hand being capable of use in pre-determining what themaximum possible velocity of a certain solute would be. In cases where the solution velocity constant is extraordinarilly high, the response to increases in the intensity of mixing action provided and/or to increase in the intensity of direct mechanical action exerted by a mixer and/or, frequently, to improvements in the distribution of a provided mixing action, except where such improvements correct a lamentably poor condition of mixing distribution, are apt to be incredibly small. Instances which are characterized by the addition of the solute in large particle-sizes and also by small and medium range solution velocity constants will on the other hand, indicate marked improvement of solution velocity upon the introduction into use of mixers exerting appreciably more intense direct mechanical action. In either low or high vebcity dissolving operations, increases in the intensity of the mixing which provided and/or improvements in the distribution of a provided mixing action above a certain modicum which are not accompanied by corresponding increases and improvements in the intensity of the direct mechanical action component of the provided mixing action are likely to fail to yield corresponding heightening of solution velocities. In fact, the improvements in solution velocity which the aforementioned conditions would be likely to induce might well be of a negligible order. The inference is not to be drawn from the above, however, that solution velocities are blindly responsive to increases in the intensities in direct mechanical action which a mixer will exert. In cases where fine size particles characterize the solute upon addition to the solvent phase, the ability of even the most intense types of direct mechanical action to influence the solution velocity obtaining is likely to be highly restricted. Finally, it is well to note the follwoing:- the saturation level of a solvent for any particular solute remains constant irrespective of the type and intensity of mixing employed; the velocity of a dissolving action varies point by point along its entire cycle, slowing down as the saturation level of the solvent phase is approached, and, hence, where the preparation of extremely concentrated or supersaturated solutions is intended, the ability to work marked improvements of the solution velocity becomes highly restricted.

16. What role does mixing play in the thinning of pastes and plastic mat
The thinning of pastes differs from the dissolving of solids in that while the latter involves the dispersion of a solid to its ultimate dimensions and the disintegration of its solids-structure, the former involves the dispersion (in almost all cases) of the solid which is distributed in the paste vehicle only to the level of particle-size which the solid already holds in the paste vehicle. The mechanics of a dissolving action involves as previously noted the neutralizing of the physico-chemical bonds which tie the ultimate components of the solute together, while the mechanics of thinning a paste involves the neutralizing by the thinning liquid/s of the physico-chemical bonds which tie the particles of the paste vehicle together. A paste, which is a dispersion of a solid or of solids in a liquid vehicle up to or approaching the full "wetting" capacity of the vehicle (the

is, where a well-dispersed paste is involved), in itself presents, from the mixing point of view, no problem which is essentially different from that which is presented by the thinning of plastic materi By plastic materials, we refer here to materials of a semi-fluid na whose consistency is of an order as to assure the absence of "slump" properties. Such materials may be pure materials or mixtures, the only qualification as to their composition being that they do not contain non-dissolved solids in a state of dispersion. A plastic material, as referred to here, may contain solids-of solution. The thinning of a plastic material, like the thinning of a paste, involv the dissipation by a thinning liquid/s of the physico-chemical bonds which tie the ultimate components of a semi-fluid mass together. Th prime components of all mixing action, the induction of flow and the exertion of direct mechanical action on a charge or a portion thereof, bears a relationship to the main mechanics of thinning identical to that which it bears to the main mechanics of dissolvin actions. That is, the generalized induction of a condition of turbulence tends to counteract the condition of localized saturation of the thinning liquid which would otherwise occur in a stagnant mix while the function of direct mechanical action is to expose a maximu area of the material to be thinned to the material which is doing th thinning.

17. In view of the material in Item 16, what claims as to probable effici in thinning operations may be honestly advancedfor mixers of one type or make or another? While the thinning of pastes and plastic materi and the dissolving of solids differ somewhat in basic mechanics, the fact that both involve a neutralizing by a liquid phase of the physic chemical bonds tying the ultimate components of at least one constit of the dispersed phase as the main mode of operation tends to relate both operations sufficiently so that almost all of what has been set forth under Item 15 applies to the subject query. The only statment under Item 15 to which a qualification must be made in order to adap the material of that section as a whole to the above-stated question the following:-namely, the statement dealing with those instances in solving operations in which fine particles-size solids are added to solvent phase. Obviously, the very character of materials of paste plastic consistency stands as a complete obstacle to the addition of such materials in a fine particle-size. Hence the qualification on the effect of direct mechanical action by mixers which was made in connection with dissolving operations in which fine particle-size solids are dissolved cannot be applied to the thinning of pastes and plastic materials. The inability to admit this limitation on the influence of direct mechanical action therefore naturally implies th direct mechanical action as afforded by mixing equipment is more universally effective in speeding up thinning operations than is the case with dissolving operations. This pronounced responsiveness of thinning operations to direct mechanical action becomes more accentuated as the amount of paste or plastic material added approac the saturation limit of the solvent or thinning liquid. In this vein it is interesting to note that the more completely the solids-conten of a paste approaches the "wetting limit" of the paste vehicle the poorer is the solvent penetration of the paste and hence the more important does the influence of mechanical action by a mixer proper

become. Similarly, in the case of plastic materials, the poorer the fluidity of the said plastic material the poorer is the solvent penetration of the plastic material and hence the more important does the direct mechanical action of a mixer become. Comparative estimates as to the efficiency of any particular type of mixer may, therefore, rather safely be made on the basis of the extent to which themixer in question exerts a direct mechanical influence. Finally, it should be asserted that the importance of direct mechanical action not only increases as the saturation level of the thinning liquid is approached but it also increases with the viscosity of the thinning liquid. However, in the case of thinning operations as with the case of dissolving operations, specific claims as to efficiency cannot be made without direct experience with the thinning operation at hand.

18. What role does mixing equipment play in accelerating the trnasfer of heat to or from heat exchange surfaces? To understand the functions assumed by mixing equipment in accelerating heat transfer it is important to realize firstly the conditions and means whereby heat is transferred in the complete absence of agitation, and, secondly under forms of agitation other than that provided by mixing equipment. The transfer of heat to or from a liquid mass, regardless of whether agitation is present as an externally produced condition or not, from far as the exchange surface is concerned is a phenomenon which, on both sides of the heat exchange surface, involves a transmission, in the most immediate sense, of heat to or from films of the media in contact with the said heat exchange surface. The transmission of heat to or from the mentioned films to the mass of which the film is a portion occurs by way of the phenomenon of convection. Convection, simply defined, is a phenomenon calling for the diffusion of the film portions of the mass of a liquid or a gas throughout the rest of themass and hence for the diffusion of heat by "mixing" the hot and the cold portions of the mass. Now are diffusion currents set up in kettles in which liquid masses are present in contact with heat exchange surfaces? Convection currents are set up by the localized, instantaneous changes in the viscosity and density of the film portions of the liquid mass which arise from the differences in temperature levels between the film portions and the rest of the batch. The aforementioned changes in density and viscosity set up movement of liquids of different density and viscosity as part of the tendency of the mass to, of itself, achieve uniformity. In kettles in which no external work is applied, these convection currents, known as natural convection, provide the prime means whereby uniformity of the liquid mass with respect to temperature is achieved. On the other hand where the transfer of heat to or fmm a liquid mass is accompanied by induced flow of liquid as is the case where liquids flow in heated ducts, pipes, etc., the transfer of heat to or from the liquid mass as a whole is actuated by natural convection alone but is aided by turbulence (where turbulent flow prevails) or by flow differentials for the various liquid films (where streamline or laminar flow prevails). In such cases, where the mass velocities for the liquid assume a high order of magnitude (where the number of pounds of fluid passing per unit of cross-sectional area of the duct is quite high), the extent of turbulence or of flow differentials, as the case may be, is correspondingly high, with the result that the extent of "forced convection" is also high. Such instances are characterized by high rates of heat

transfer, providing that the conduction of heat thru the heat tran surface and the transmission of heat to or from the other side of the heat exchange surface does not limit the overall transfer of h Mixing as established by normal liquid mixing equipment introduces an expenditure of energy into the liquid mass much as in the fashi of the energy which is expended in establishing high mass velociti in a duct against the total resistance heads which such high mass ocities entail, and, hence, establish a similar condition of "forc convection".

19. In view of the material in Item 18, what claims may honestly be advanced in support of one piece of mixing equipment or another as means of accelerating heat transfer? Three basic items enter into determining the magnitude of the overall coefficient of heat transf which would obtain for exchange of heat across a metallic surface:- the efficiency of heat transfer effected by the medium or means on t far side of the exchange surface; conduction thru the metallic surf proper; and, the efficiency of heat transfer, or film coefficient, o the batch-side of the exchange surface. These factors are so inter related so that if any of the named factors is appreciably lower tha the other two the overall coefficient as a whole is dragged down to level of the lowest factor. For almost all metals of fabrication no mally used and for such thickness of those metals as are normally employed, the "metal film" would never constitute the "drag" in determining the magnitude of the overall coefficient of heat transf Where the far-side of the heat exchange surface is heated principall by radiation (i.e. where the far-side acts as a partial "black body" absorbing heat from a refractory wall, etc.) or is heated by being in direct or baffled contact with a flame, we are privileged to assu that if the furnace, in the first case, is properly designed or if the design of the burner and its use is proper, in the latter case, far-side of the heat transfer surface will not act as a "drag" in th aforementioned sense. Where the far-side of the heat exchange surfa is in contact with most normally used heat transfer vapors (i.e. st Dowtherm, mercury), the far-side efficiency will not act as the "dr since the variation of the given vapor film coefficients with variations in mass-velocity is not of such an order as to account f the limitations in heat transfer which normally attend the transfer heat in agitated kettles. On the other hand, where liquid phase he exchange media are employed (such as hot or cold water, brine, oil, the range of mass-velocities which are attained for these media in most jacket and internal coil installations are of an order of magnitude as to definitely restrain the value of the overall coeffi of heat transfer to moderate or low limits. Dealing lastly with the film coefficients attained for batch-side of heat exchange surfaces in mixing kettles, we may most decidedly say that it is this aspect which in most cases exerts the most restraining influence in determi ing the value of the overall coefficient of heat transfer, since un normal mixing intensities (i.e. under those intensities of mixing wh are mechanically and economically feasible) the condition of "forced convection" which is set up barely approaches the limits which are required for high film coefficients. To be sure, the value for the

batch-side film coefficient under agitation will usually be decided higher for proper intensities of agitation than is the case for non agitated batches, the sharpness of the difference being more marked the viscosity of the agitated mass increases. But, reduced to essentials, will different types of agitators induce rates of heat transfer which will differ from one another appreciable? Assuming equivalent qualities of mixing distribution and reasonably similar intensities of work-input into a mixing kettle, the film coefficients which would be obtained would not very significantly from one another. Analyzing the background which underlies the aforegiven statement, the reasons for its validity become apparent. As was previously set forth, the prime components of a mixer's action are:- firstly, the induction of flow and, thereby, of some condition of turbulence; and, secondly, the exertion of a direct mechanical action upon those portions of the charge with which the mixer is brought into contact. Though mixers will vary considerably in the proportions of their work-requirement which will go to the exertion of a direct mechanical action, the principal component of the activity of almost all types of mixers which are inserted into mixing kettles is the induction of flow in the liquid batch. Regardless of the type and direction/s of flow which such mixers set up, the extent of flow which is established, and hence the degree of turbulence which obtains assuming equivalent distribution of the provided mixing action, will, under identical kettle conditio bear a strict relationship to the amount of work-input which goes into circulatin liquid. Where random flow obtains, as is the case with all equipment in which draft-tubes and/or directive baffles of special types are not employed, the efficiency of translation of Drive energy to circulation, and, therefore, if as stated above the principal component of most mixer's activity is the induction of flow, under reasonably equivalent intensities of work-input the conditions of turbulence which are created will remain similarly equivalent. Apropos of such differences in actual translation of work-requirement to circulation as do exist for certain mixers in consequence of the proportion of work which goes into direct mechanical action by the mixer and apropos of the purposes which may be served by indulging in comparatively small increases in the intensity of mixing action (where intensity is measured in terms of Drive horsepower per unit of volume of batch), it is well to note that:- firstly, the efficiency with which Drive energy is translated into circulation is of a very low order; and since the response in terms of increases of film coefficients to increases in circulation is not a linear one but one following a fractional power value of the rate of circulation induced, neither the normal differences in circulation translation of most mixers at equivalent work-input levels nor the somewhat larger differences as to work-input level which may be resorted to while still holding to levels consistent with economical expenditure of energy will result in appreciable influence on the rates of heat transfer effected so long as the originally employed intensity of work-input is of a magnitude sufficient to establish at least a modicum of turbulence. As regards the previously voiced comment that the influence of agitation is most marked in improving the condition of heat transfer over those instances in which no agitation is employed where vviscous liquids are dealt with, it might be well to note here that similarly startling improvements in the rate of heat transfer effected may be worked in cases where "build-ups" of scale, crystals, or plastic substances on heat transfer surfaces are produced and where scraper type agitators are employed to remove the said "build-ups". Finally, it should be added that directionalized mixing as produced by the influence of directive baffles and draft-tubes will frequently produce more pronounced effects than will rather drastic increases in the rates of circulation induced.

20. What functions can mixing equipment perform in conditioning crystallization operatings? In order to treat this subject, it is important to define what can be meant by "conditioning a crystallization". Crystallization operations are frequently characterized by a desire to obtain crystals having a certain size and structure. The factors which can, in the most immediate sense, exert an influence on crystal size and structure are:- the rate of production of crystals; the introduction of "seeds" or cores about which a crystal will form; the extent of secondary or direce mechanical action which is brought to bear on the liquid mass in which the crystals are suspended; and the chemical characteristics of the solution from which the crystals are thrown out. The rate of crystal production, based as it is upon the varying degree of solubility of a solute in a solvent at various temperatures and based as it is upon the removal or input of the heat of crystallization from or into the crystallization system, is capable of being translated into terms of heat transfer. A mixer may therefore condition a crystallization to the extent that it influences the conditions of heat transfer. "Seeds" or cores are particles present in the solution prior to crystallization proper which act as surfaces or focal points for crystal growth during crystallization. That is to say, the crystals which are formed elect to grow around the provided "seeds", and, hence, the "seeds" form the foundations for crystals. There are two ways in which "seed" may be introduced into a crystallization syste firstly, by addition prior to beginning the actual crystallization operatio the added "seeds" constituting a supersaturation of the existing crystalliz solution; and, secondly, by forming as part of the original procedure of placing the solute in solution a supersaturated solution of the solute. A mixer may therefore condition a crystallization to the extent that it either performs the distribution of a "seeds"-addition or that it prepares the condition of supersaturation upon which the presence of "seeds" may be predicated. A mixer may furthermore condition a crystallization to the extent that it combines a sufficient condition of circulation of the formed crystals, if that is desired, or that condition of agitation which is turned to the degree of mechanical breaking down of the crystals that can be tolerated; or to the extent that it provides for a circulation of the solution while at the same time allowing the settling of formed crystals (that is, the settling of crystals which have attained a certain pre-determ growth); or to the extent that the mixer provides for the removal of crystal-growth from heat exchange surfaces. Finally, a mixer may condition a crystallization operation to the extent that it provides for the distribu of agents whose purpose it is to alter or affect the chemical characteristi of the solution from which the crystals are thrown out.

21. Why is it important to know the specific gravity or density of solids whichmay be added in liquids in mixing operations, and, also, the starting mean particle-size of the said added solids? Unless very special conditions obtain and it is distinctly desired than an added solid be kept either floating on the surface of the liquid phase or settled at the bottom of a tank, the density or specific gravity and the start mean particle-size of the solid would determine whether the material would have a tendency to float (i.e. the specific gravity of the material would determine this possibility) or whether the material would tend to settle, and if so, at what rate the particles would tend to settle (i.e. the specific gravity and particle-size of the added solids would determine not only the possibil of settling but the rate of settling in stagnant water--or any other fluid-- as well). Knowing the starting particle-size of the added solids would

furthermore establish the probable effectiveness of the degree of d mechanical action of any mixer which we might provide for any solid liquid mixing system at hand. In cases where direct mechanical act on added solids is desirable, and particularly where special modif- ications of normal mixers are employed in which rotor-to stator rel ships are set, it is also advisable to have some knowledge of the hardness of the added solids. Obviously, the hardness of an added solid would have a considerable bearing on the probable effectivenes of such direct mechanical action as we might be able to provide. Determining whether there would exist any great tendency towards flo for any solid at hand or a high rate of settling would, of course, b essential not only in selecting a proper type of mixer to counteract either of the said tendencies but would as well enter into consider- ation with regard to the possible use of "directionalizing" or mixing or accentuation of mixing actions thru the use of directive baffles or draft-tubes.

22. What bearing can appreciable differences in the specific gravity and viscosity in liquids have in the design and selection of mixing equipment? Large differences in the specific gravity of any two liq which are to be mixed may, especially if accompanied by appreciable differences in viscosity, lead towards a condition of "layering". T conditions which tend to accentuate such tendencies, and hence to ma the job of achieving dispersion more difficult, include:- poor diffusibility of the liquids in one another, or complete immiscibilit of the liquids in question; poorly shaped kettle; unusually large vessels; and, poorly distributed mixing action. Where large differen in viscosity exist, either in combination with large differences in specific gravity or alone, the retarding effects on the speed, and, frequently effectiveness of dispersion which are entailed in consequ of thesaid differences in viscosity may be counteracted by employin, a maximum of direct mechanical action on the viscous charge.

23. Why is it important to be informed as to whether it is intendedto introduce gases during mixing operations and why should the feed- pressure for the gases be noted in such instances? The tendency of gases to rise and escape rapidly when introduced into liquids is almost always an undesirable feature of such operations. Where gas- liquid reactions, the dissolving of gases, aerations, flotations, and many other gas-liquid mixing operations are involved, the rapid escape of introduced gases tends to reduce the speed of the operatio involved as well as result in poor efficiencies. The measures which may be adopted to counteract the rapid escape of gases (SEE SECTION MANUAL WHICH TREATS WITH GAS LIQUID MIXING OPERATIONS) include: introducing the gases at optimum locales with respect to the mixing equipment; proper "directionalizing" of the provided mixing action; and, employing distributor rings, pipes, etc. of optimum design. Th proper combining and use of the separate consteractions thus nominate has the effect of reducing the bubble-size to which the gas is dispersed to a minimum, maintaining the path of travel for the gas in escaping at a maximum; and, assures the widest possible distribut for the gas throughout the liquid phase. Reducing the bubble-siz s which a gas is distributed has, of course, the tendency to lessen th "buoyant" lift of the gas. Why is the nomination of the available

feed-pressure important? Where certain rates of gas-introduction are desired, three factors are of prime importance:- the back-pressure against which the gas must be fed; the diameter of pipe which is employed to lead the gas as well as the nature and type of the diffuser orifices; and the feed-pressure. The main components of the back-pressure against which the gas must be fed are:- the static head of liquid above the distribution level; and the total gas and/or vapor pressure above the liquid level. The diameter of the pipe being used and the amount of gas being fed, as well as the physical characteristics of the fed gas determine the frictional head against which the feed-source must operate. The distributor member itself contributes towards the frictional impedance to flow. The difference between the feed-pressure and the total back-pressure, in turn, defines the "flow potential" across the lead-pipe and distributor assembly as a whole. It might well be noted that inadequate design of the lead-pipe and the distributor, from the standpoint of the total frictional head which a bad design might entail, will not only restrict the amount of gas which will be passed by the said assembly, if the feed-pressure is of a sufficiently low order, but it will frequently redound to:-

1. where non-positive types of gas "propelling" equipment such as blowers, fans, etc. are used, will result in either a sharp reduction of the "propelling" capacity or in an overloading of the "propeller's" Drive

2. where positive types of gas "propelling" equipment is used such as reciprocal compressors, etc., result in either considerable "idling" of the equipment, or, if no overloading safeguards are provided for the equipment, stall the same.

24. <u>What bearing does the viscosity of a mixture have on the power consumed by a mixer? and why?</u> In rotary types of mixing equipment with which we are treating here, the effect of viscosity may best be appreciated by defining the meaning of the word in its simplest aspects:- A liquid's viscosity is its internal friction;---the frictional resistance which one part of the liquid offers to motion by another part. What does this mean? As previously explained, the main function which mixers of the type which are used in connection with agitating the contents of a vessel perform is that of inducing flow of all or some part of the vessel's contents, creating as a function of the relatively random flow which they induce a condition turbulence which, in the best instances, is transmitted throughout the vessel's contents. The ability to transmit or radiate turbulence from the immediate scope of the mixer's action to the outermost regions the vessel, if we discount the impedance which poor kettle design or internal baffling structures tends to induce, varies inversely with ability of the mixed liquid batch as a whole to resist its own flowing portions, that is, the ability to transmit turbulence varies inversely with the liquids viscosity. But that is not all. Most frequently a high viscosity may as well be associated with a high and tenacious cling of the puripheral portions of the mass to the vessel structure itself as well as with a tenacious gripping of structures inside the vessel. This firm gripping of the vessel wall and structures

not only damp[illegible] the general process where[illegible] turbulence is created but will as well resist the relativemotion within itself of such members as agitator rotors. In view of these considerations, the effect of high viscosities is to increase the amount of power required to establish the levels of turbulence which are equivalent in mixing act to those which are set up in the case of liquids with lower velocities and, also, to require a greater amount of power in order to establish rates of motion for theagitator members proper which are comparable to those set up in less viscous materials.

SAC

June 25, 1950

SA T. SCOTT MILLER, JR.

HARRY GOLD, was.,
ESPIONAGE - R

Exhibit 65-4307-1B1-12 (4) - Folder #8 # 10

MATERIAL FOUND IN WOODEN BOX
IN BASEMENT OF GOLD'S HOME

The above material, which was contained in a manila folder entitled, "1. The Hendrick Co's Material on Mixing. (B says that this is also his work)," was shown to GOLD on June 22, 1950.

Contained in this folder are twenty-five (25) typewritten pages entitled "Questions and Answers Re the Liquid Mixing Data Sheet." GOLD advised that this was part of the data which BROTHMAN gave GOLD on mixing data, which was to be turned over to the Soviet Union. GOLD is of the opinion that the reason he still has this material is that it was supplanted by a revised report. He stated that it was about September 1942 that BROTHMAN gave him this material. GOLD is of the opinion that this material might have been shown to SAL because of GOLD's handprinting on the front stating that this was also BROTHMAN's work.

Exhibit 65-4307-1B-12 (4) - Folder #11 # 11

MATERIAL FOUND IN WOODEN BOX
IN BASEMENT OF GOLD'S HOME

This too was shown to GOLD on May 22, 1950 and the material was in a manila folder entitled "3. B's work (not yet complete)."

GOLD advised that this was part of the data in folder #8 above and was also given to him by BROTHMAN, possibly at a different time, for submission to the Soviet Union. GOLD is of the opinion that the notation that the work is not completed is the reason that it is still in his possession and was maintained by him when BROTHMAN gave him a final report on mixing data which supplanted this, as well as the material in folder #8.

The material in folder #11 runs from page 29 through page 51 and is entitled "Gas - Liquid Mixing Operations."

TSM:as
65-4307

GAS-LIQUID MIXING OPERATIONS

The absorption of a gas/es by or the reaction of a gas/es with liquids (or the absorption by or reaction with materials in solution in liquids) depends on:-

1. the ability of the gas/es to dissolve in the liquid in which the gas is distributed

2. the time of actual contact established between the distributed gas and the liquid in which it is dispersed

3. the area of contact established between the gas/es and the liquid phase.

Taking each of the above-named major factors in turn, they may be reduced to the following more primary conditions:-

The ability of a gas to dissolve in a liquid in which it is dispersed is controlled by:-

a. the pressure or partial pressure which the gas exerts (Henry's Law)

b. the temperature of the gas and the liquid phases

c. the size of bubble to which the gas is distributed (i.e. the area of contact between the gas and liquid phases)

The elapsed time of contact between a distributed gas-particle or bubble and the liquid in which it is distributed is controlled by:-

a. the viscosity of the liquid in which the gas is distributed

b. the height of liquid through which the gas bubble must rise in escaping

c. the route or path through which the gas-bubble must travel in escaping

The area of contact which is established in a gas-liquid dispersion is controlled by:-

a. the degree of direct mechanical action by the mixer elements proper to which the gas-bubble is subjected during its introduction and stay in the liquid

b. the degree of turbulence which exists in the liquid phase in consequence of the mixing action/s provided, and, hence, the extent to which the bubble is continuously "bruised" by the liquid phase during its stay in the liquid

The importance of a continuous application of shearing action is always great in view of the tendency of colliding bubbles to coalesce and hence reduce the effective area of contact between the gas and liquid phases. It is of prime importance---that is, of even greater importance where the product of the absorption of the gas or of the reaction with the gas is a liquid, which because of its viscosity or its miscibility, tends to diffuse poorly in the liquid-of-distribution, or where the product is a solid, which because of the extent of its extent of solubility or its inherent rate of solution, tends to "bug" the gas-bubble [illegible] that they dissolve as soon as it is formed.

In view of the above, a mixing assembly which is intended for service in a gas-liquid mixing operation where an absorption of the gas or a reaction with it is contemplated must satisfy the following minimum demands -

1. it must establish a maximum condition of turbulence for the gas-liquid mixture

2. it should involve the location of the point/s of gas-diffusion or introduction as closely as possible, without impairing the mixer's action, to the locale of the mixing unit proper so as to accomplish the gas-distribution at the scene of most intense mixing action. The practicality of this suggestion will seem most reasonable if it is noted that the zones in the immediate vicinity of the mixer proper are the regions of highest fluid velocity, and hence diffusion in such a zone necessarilly entails the widest possible distribution through the liquid batch of the gas and also a maximum subjection of the gas liquid mixture to "turbulents effects"

3. the mixing assembly should involve, if possible, the diffusion or introduction of gas in a stream passing thru the mixer elements proper as a means of bringin a maximum of direct mechanical action to bear on the introduced gas

4. the path of travel of the liquid phase, and the gas which is introduced into it, should be so directionalized by directive baffles, or draft-tubes, or by reason of the mixer's own mode of flow-induction as to assure a maximum path of travel for the gas prior to escaping, so as to assure the most tortuous possible path of travel for the gas-bubbles

5. wherever, possible, the above-cited effects should be augmented by means for re-introducing the "stagnant" portions of the introduced gas which collects above the liquid level back into the liquid

SEE SECTION ON DRAFT-TUBES AND THE SECTION ON DIRECTIVE BAFFLES IN RE THE PROBLEM OF GAS-LIQUID MIXING

SOME IMPORTANT GAS-LIQUID MIXING PROBLEMS

The number and specific types of gas-liquid mixing operations with which one can expect to meet are, in the last analysis, virtually limitless. It is therefore quite impossibl to go into an exhaustive listing of the same. The following are, however, either broad classifications of gas-liquid operations which are fairly common as broad groupings, or specific operations enjoying a wide useage:-

Hydrogenations:- are processes in which organic substances which are unsaturated (i.e. which do not contain the maximum number of hydrogen atoms which they are capable of containing in their structure) are reacted with, or saturated with, hydrogen. Hydrogenations usually take place in the presence of catalysts, Nickel, copper, and platinum, but most usually nickel, have been used as hydrogenation catalysts. The most commonly known instances of hydrogenation include: the hydrogenation of oils form shortenings; the hydrogenation of dyestuffs; and the hydrogenation of unsaturated fatty acids

Reductions:- are processes in which organic or inorganic materials are de-oxidized. The most common instances of reductions include:- instances here oxides of metals are brought down from one stage of oxidation to another or where oxides of metals are destroyed to regain the pure metal itself; instances where organic acids are reduced to aldehydes, or to alcohols, or to the corresponding hydrocarbon to which they are related; and, instances in which organic materials called ketones are reduced or brought back to secondary alcohols. Reducing agents include a wide variety of agents for accomplishing the same, hydrogen being one of the most widely used of these. Reductions involving hydrogen as the reducing agent are widely met with in the field, and constitut a common gas-liquid reaction. The reduction may, in some cases, involve, where the reduction takes place in a gas-liquid system, not the liquid in which it is dispersed directly but some material which is suspended or dissolved in the liquid

Oxidations:- are processes in which materials, either organic or inorganic, are reacted with air, or oxygen, or ozone for the purpose of introducing oxygen into the structure of a compound, or for the purpose of uniting an element with oxygen, or for the purpose of decreasing the hydrogen content of a compound, or for the purpose of increasing the oxygen content of a compound. The reaction when air is used as the oxidizing agent is with the oxygen component of the air. Oxidations may involve the use of oxidation agents other than those named above, but the most common form of gas-liquid reactions which are oxidations do use the agents listed in the definition given above. Oxidations are common to all branches of industrial chemistry

Aerations:- are processes in which air is introduced into a liquid most usually for the purpose of volatilizing low boiling point materials contained in the liquid, or for the purpose of feeding air to bilogical organisms contained in the liquid. Oxidations using air and aerations may be distinguished from one another most usually in that either the latter involves a purely physical phenomenon rather than a chemical one or in that, even if a chemical or biochemical reaction is involved, the primary purpose of the introduction of air is the satisfaction of a "biological demand"

Sulphonations:- are processes in which either acid, concentrated sulphuric acid, sulphur trioxide, or any combination of the aforegoing agents are reacted with organic materials of the unsaturated type (NOTE:- see section above on hydrogenation for definition of unsaturatio for the purpose of forming an addition compound between the unsaturated organic and sulphuric acid. Such sulphonated products are frequently met in the manufacture of detergents and in various fields of organic synthes where the sulphonated product is commonly regarded and produced as a reactive intermediate stage in a synthesis sequence. Most usually, sulphonating agents of the liquid type (i.e. concentrated sulphic acid, fuming sulphuric and similar liquid agents) are employed. However, the of sulphur trioxide gas alone as a sulphonating agent, where the organic compound contains liberal amounts of water, is a fairly common procedure.

Halogenations:- are processes in which chlorine, or its chemical family members---bromine, flourine, and iodine, are reacted with organic material for the purpose of bringing a halogen atom/s into the structure of the organic. The mechanics whereby the halogen atom/s are brought into the structure of the organic may include:- either, substitution---which as a term describes a method whereby the halogen replaces hydrogen atoms in th structure of an organic; and/or addition---which as a term describes a method whereby the halogen atom/s saturates unsaturated organic compounds Where the halogen is reacted with a saturated organic compound, the mechan of the halogenation is substitution. Where the halogen is reacted with as unsaturated organic material, the mechanics of the halogenation may include both substitution and addition, temperature and the use of catal determining the precise extent of each of the aforementioned basic methods prevails or even whether one or the other ceases to exist as a factor in the case at hand. Chlorinations and brominations, as instances of halogenations, are gas-liquid reactions where the material to be halogenated is a liquid or is dissolved or dispersed in a liquid. Iodinatio as another instance of halogenations, may either be, if the material to be iodinated is a liquid or dispersed in a liquid, instances of liquid-liquid reactions or solid-liquid reactions, depending upon the temperatu at which the mixing operation takes place. Reactions of liquids and/or solutions in the inorganic field with chlorine and bromine are common instances of gas-liquid reactions, but, strictly speaking, may not be considered halogenations, since the term halogenation is peculiar to the field of organic chemistry. However, whether the gas-liquid mixing at a operation involves halogenation or a mixing of an inorganic material with chlorine and/or bromine it should be carefully noted that the corrosin problem, for most common materials of construction of mixing equipment, where wet (water-wet) conditions prevail is of such an order as to require submission of all the facts at hand on the operation to the Home Office for their recommendations as to the proper material of fabricatior

Blowing of Oils:- are processes in which air is introduced into vegetabl and animal oils (linseed, Perilla, Chinawood as the most common instances of vegetable oils used, and herring oil as the most common instance of an animal oil) for the purpose of obtaining a product having certain "wetting" properties, for the purpose of obtaining a product having certa viscosity characteristics, and certain properties of chemical stability. Though blown oils are widely used in the manufacture of linoleum, paints, varnishes, and insulations, very little is known of the exact chemistry

behind the operation. Qualitatively, it is known that the blowing of oil entails two phenomena:- firstly, an oxidation, and, secondly, a polymerization. The proportions or relative magnitudes which these basic phenomena bear to one another may be varied through the use of:- different temperatures during the blowing operation; by controlling the amount of air entering the oil to certain levels; by interspersing blowing periods (periods during which air is introduced) with resting periods (periods during which the oil is allowed to "vegetate" under the influence of heat alone. The extent to which polymerization or oxidation prevails in the oil processing operationdetermines the physical and chemical properties of the produced oil.

Gas-scrubbing:- are processes in which one or more gases present in a mixture of gases is elimenated from the mixture of gases. Passing the mixture of gases through pure liquids, solutions, suspensions of solids in liquids, or through "banks" of "active" solids alone form the basisof all gas-scrubbing operations. Passing the mixture of gases through liquid systems of one type or another or bringing them into contact with liquid sprays are the means which re most usually employed in gas-scrubbing. It should be noted in connection with the above that operations involving the removal of entrained liquids or solids in gases arealso frequently referred to as scrubbing operations. Such instances are also subject to the comments which have been made above. For the cases of gas-liquid scrubbing systems the mechanics whereby scrubbing is achieved may be any one or combination of those noted below:-

1. a gas/es, and/or a solid/s-of-entrainment, and/or a liquid/s-of-entrainment may be eliminated from a gaseous-stream by absorption (i.e. clinging) on an "active-surface" solid which is suspended in liquid. Systmes relying in part or in full upon this type of motivation for scrubbing involve most frequently gas-liquid mixing of the type which we treat with

2. a gas/es, and/or a solid/s-of-entrainment, and/or a liquid/s-of-entrainment may be eliminated from a gaseous-stream by a chemical reaction of the aforesaid materials with a liquid reagent, or with a solution of a reagent, or with a suspension of a reagent. Equipment based upon this principle of operation either principally or in full may be of either of two basic types:- where large volumes of gas are being handled, spray chamber or towers will be employed, and, where low to medium rates of gas-handling are called for, equipment of the type which we would furnish is used. The one notable exception tothe above-stated rule in re the types of equipment employed is the following:- where suspensions are employed as the scrubbing media, the use of spray towers is most usually limited to suspensions of low dry-contents, and, hence, where suspensions of high dry-contents are used, either cascade towers or conventional equipment of the type which we can furnish are employed

3. a gas/es, and/or a solid/s-of-entrainment, and/or a liquid/s-of-entrainment may be removed from a gaseous stream by straightforward physical solution in a liquid. Equipment based upon this principle of operation either principally or in full may be of either of two basic types:- where large volumes of gas are handled, spray cham

or towers are used while, where small to medium volumes of gas are handled, gas-liquid mixing equipment of the type which we would furnish would be used.

Flue-gas scrubbing is a special instance of the general problem of gas-scrubbing and most frequently involves the recovery of carbon dioxide fro flue gases, either for the purpose of immediate conversion of the said component of the flue gas to "dry-ice" or some immediate plant-use or for purpose of "bottling" the carbon dioxide for sale as a by-product. The g solids, and liquids which must be eliminated from the flue-gas to prepar to prepare the carbon dioxide component for use depends upon the fuel whic is burnt at the flue-gas source and the efficiency of the measures which are taken to scrub the flue-gas depends upon the purity which the "re-use demands.

Gas-gas Reactions taking place in a common liquid medium:- are instance in which two or more gases capable of reacting with one another are dispe in a common liquid "bath". Either of two circumstances may lead to carry a gas-gas reaction in the aforementioned manner:- firstly, the product of the gas-gas reaction may itself be a liquid which catalyzes the reaction the "bath" which is provided may exert a catalytic effect upon the reacti where the "bath" is a material which is the the product of the reaction; or, secondly, the gas-gas reaction at hand may be of such a vio and exothermic (heat-producing) nature that the taking-place of the react in a liquid medium offers optimum conditions for heat transfer and temper control. Many of the chlorinated solvents which are produced from gaseou hydrocarbons and chlorine are produced after the manner set forth above, the solvent product itself serving as the "bath" material.

Gas-bleaching of Juices, Oils, Paper Stock, etc:- are instances in which chlorine, or sulphur dioxide, or oxygen, or air, or ozone, or mixtures of gases having similar properties are distributed in liquid materials or in suspensions of solid orfibrous materials for the purpose of "bleaching" or decolorizing the liquid ors pend-d materials. Most usually such operati are carried out by relying upon the "bubbling" of the gas/es through the liquid phase for the required agitation of the system. Economies may ver frequently be introduced into these operations by the use of other sources of agitation such as may be provided through the employment of normal liqu mixing equipment, and, especially, where the said liquid mixing equipment is adapted to the special conditions prevailing because of the introductio of gas/es into the liquid phase. This is particularly true where large volumes of gas/es are fed into the "bleaching" system.

Mineral Ore Flotation:- is a process used for the separation of certain solids from mixtures of solids. The process is widely used inthe separati of ores from the impurities with which the ores are found, as well as for the separation of mined salts from their respective impurities. Recently, modifications of this process have been employed in other industries for a variety of separation operations. Flotation, as applied to ores, consists of the following sequence of operations:-

1. the ore mixture is crushed and ground to a fine powder in crushin and pulverizing equipment. Where the ore is particularly tender, the crushing and pulverizing may be accomplished in liquid mixin

equipment which exerts a high ratio of direct mechanical action on a slurry charge. When the "mechanical reduction" of the solids-charge is accomplished through the action of mixing equipment as described above, it forms one of the functions of the mixing equipment, theothers being, as set forth in the following operations

2. the ore is dispersed, that is to say--the finely ground particles thereof, in a flotation vehicle, normally water

3. a flotation agent, normally a colloidal material, is distributed throughout the ore slurry for the purpose of selectively enveloping the particles which are to be separated from the "reject"

4. air is distributed through the mixture, as set forth above, as for the purpose of "linking" to the flotation-agent-enveloped particles (i.e. the floation agent serves as a chain binding the particles to be separated to the dispersed air-bubbles)

5. the rising and escaping of the air-to-flotation agent-to-solid particles, based on the lift properties of a gas when dispersed in a liquid, causes the selectively coated particles to come to the surface of theequipment as a "scum"

Flotation, except when carried on a laboratory basis, is a continuous operation. Surface rakes continuously sweep the "scum" towards a weir, while the continuous flooding of the equipment with new water by setting up a condition of overflow attends to the "conveying" of the raked scum to further stages of the processing sequence. At least, Stages 2.3.4. and 5 are within thescope of a normally well-designed gas-liquid mixer; while, as noted above, with conditions permitting the mixing equipment may simultaneously be designed to carry out a pulverizing action. In cases where the flotation mixing machine is charged with the task of carrying out the pulverizing action as well, it is interesting to notethat since the "lifting ability" of the dispersed air-bubbles is limited the flotation of particles weighing over a certain minimum is impossible and hence the reduction of the crude charge to a certain uniform minimum level is assured.

Blowing of Asphaltum:- is a process calling for the distribution of air in molten asphaltum for the purpose of promoting, as inthe blowing of oils both an oxidation and a polymerization. The principles which guide the carrying on of this operation are as poorly understood quantitatively as in the case of the blowing of oils. And hence theassociationof certain procedure with the attainment of certain physical and chemical properties for the product is smilarly a purely empirical one following much along the lines previously set forth in the case of blown oils (SEE ABOVE)

Steam Distillations:- are operations in which live steam is introduced into a liquid system for the purpose of volatilizing certain or all of the components of the aforesaid liquid system. Some portion of the latent heat present in the introduced steam, depending upon whether the water condensate due to the presence of the steam and its use is miscible wth

the aforementioned liquid system and depending upon the vapor pressure properties of the aforementioned liquid system, goes to the distilling of certain components or all of the liquid system. The role of efficient gas liquid mixing in such operations is to assure the distribution of the steam in minimum size bubbles and hence to reduce the "lift" rate for the bubble. The reduction in the "lift" rate for the bubbles of steam assures a greater period of stay in the liquid batch and hence the ratio of the yielded quantity of heat per unit of steam used to the theoretical quantity of heat which each volume of heat should give up approaches a maximum.

Washing of Natural Gas:- is a process which may be considered a special instance of gas-scrubbing as previously dealt with. The object of the operation in this case is to extract such solid particles as may be entrained in the gas as well as the hydrogen sulphide which is always present in natural gas. All of the comments previously set forth in connection with the section above dealing with the general problem of gas-scrubbing are applicable here in view of the many different basic means whereby the extraction is carried out and in view of the variations as to size which govern installations of this type.

SOME SPECIAL LIQUID-LIQUID MIXING PROBLEMS

The vast majority of liquid-liquid mixing problems may be handles by the normal and standard mixing equipment which is represented by the turbine, propeller, paddle, gate, horseshoe, etc. types of mixers which are commonly marketed. In such problems, the only functional advantages which one vendor has over another will consist of:- whether the specific type of mixer recommended is suited to the type of kettle employed. the volume of material to be handled, and the physical characteristics of the material to be mixed; whether the intensity of mixing action (the horsepower per unit of volume) is optimum for the job at hand: and, whether the speed characteristics of the chosen mixer are suited to the conditions of the mixing problem at hand. In such problems, the design advantages which one vendor will have over another will consist of:- the extent to which the component members of the mixer are structurally sound (whether shafting of adequate diameter has been used, whether the mixer blade members are of adequate strength, whether the means of mounting the mixing assembly are sufficiently rigid, etc.) and suited to long-life; and, the extent to which the mixing equipment for a sound mechanism (the extent to which the unit embodies not only operational soundness such as freedom from excessive vibrations, etc. but the extent to which optimum life for the Drive, stuffing box, bearings, etc. has been provided for).

There are, however, some categories of liquid-liquid mixing problems, and some specific instances of liquid-liquid mixing problems, which are either poorly carried out by the normal and standard types of mixing assemblies, or are carried out with huge inefficien from the standpoint of the work-accomplished per unit of energy expended. All of the reasons for the inadequacy of normal and standard mixing equipment in such instances may be ultimately resolved into any one or combination of the following basic condition inefficient and improper means and procedures of addition of one liquid to another; the inadequacy of the normal "character" of mixing action which a standard mixer provides for the job at hand;- and, failure to assist the normal action of the mixer at hand with flow-directive baffles, draft-tubes, etc.

The following is a list of the more common liquid-liquid mixing problems which one is likely to meet. Included under each heading is a terse [illegible] of the nature and types of difficulties which each is likely to present:-

Sulphonations:- A general exposition of what is a sulphonation is has been given on Page 33. The treatment which is given there applies in general to all sulphonating operations, regardless of whether the sulphonating agent is a liquid or a gas or both. The following difficulties are also common to all sulphonations regardless of the type of sulphonating agent employed:-

1. Sulphonations as a class are extremely exothermic reactions (produce a large amount of reaction-heat). This condition, when coupled with the fact that all sulphonating agents are extremely active dehydrating agents, tends to set up the maintaining of certain maximum temperature levels as an absolute pre-condition to the obtaining of a good product since the dehydrating effect of the sulphonating agents is accelerated by heat. This factor is of paramount importance where the organic material which is being sulphonated contains oxygen as well as hydrogen in its structure. Where the compound to be sulphonated does not contain oxygen and hydrogen atoms and, hence, where dehydration cannot take place, there exists the following danger. The nature of the reaction which takes place, the precise nature of the material produced, is in almost every known sulphonation rather critically dependent upon the temperature conditions under which the reaction occurs. These facts

demand that all possible measures be adopted to maintain and ensure the maximum conditions for good heat transfer

2. since most of the materials which are commonly sulphonated are imiscible with the normally employed sulphonating agents the problem of assuring the instantaneou dispersion of the sulphonating agent upon addition of the same in the reaction system is also exceedingly important and crucial. Accomplishing this goal, instantaneous dispersion of the agent, is made more difficult than would normally be the case for most imiscible materials by the fact that the commonly employed sulphonating agents enjoy a specific gravity much higher than that ofmost liquid materials. In view of the fact that the heat which must be removed arises as soon as contact between the sulphonating agent and the material to be sulphonated is established, the normal mode of addition of the sulphonating agent to the reaction-system is a gradual one. This is done both in the interest of heat control and in the interest of providing the best possible conditions for immediate dispersion of the sulphonating agent on addition

3. where the sulphonation of oils is involved (NOTE:- sulphonations of oil are most usually pursued for the purpose of manufacturing detergents, a further complicating factor is added to the two cited above. In those instances, the high viscosities of most sulphonated oils and their tendencies to deposit a viscous film on heat exchange surfaces tends to extend the difficulties which are experienced in maintaining good heat transfer and instantaneous idspersion of the sulphonating agent upon addition of the same to the system. The difficulties experienced in establishing the aforesaid instantaneous dispersion of newly added sulphonating agent becomes most pronounced towards the end of the reaction, when the general viscosity of the reaction system is at its maximum

The extreme variety of materials which are sulphonated and the varying circumstances under which these reactions are carried out makes it virtually impossible to establish specific remedies against the aforementioned difficulties which would be universal. It is possible, however, to set forth the following general rules regarding the above:-

1. to establish the best possible conditions for heat transfer in connection with heat exchange surfaces, measures to assure a forced drift, wherever possible, should be provided for (SEE SECTION ON DRAFT-TUBES)

2. to establish the best possible conditions for instantaneous dispersion of the sulphonating agent on addition to the reaction-system, the point of addition or distribution of the sulphonating agent should either be into a stream passing into a mixer unit, or a mixing unit's path of action; or, where the mixer induces a high velocity flow, into the impelled stream. The point of introduction of the sulphonating agent should in any case be in the vicinity of the scene of most intense mixing action

3. where either a starting high viscosity system is involved or where the reaction-system demonstrates a progressively increasing viscosity as the reaction proceeds, both of the above cases will be aided if a mixer combining high rates of flow-induction and a maximum of direct mechanical actio is employed

Nitrations:- are processes in which organic materials are reacted with any one or combinations of the following agents:- nitric oxide, concentrated nitric acid, and fuming nitric acid, for the purpose of adding a nitro (NO_2) group to the structure of the organic at hand. The most common nitrating agent is a mixture of nitric acid and sulphuric acid. The sulphuric acid performs the function of taking up the water which is produced as a by-product of the nitration reaction and also as a counter-measure to the oxidizing tendency of nitric acid. The difficulties and demands which nitration involve are similar to those cited above for the case of sulphonations:-

1. almost all nitrations are exceedingly exothermic, while at the same time the requirements of producing products of certain chemical and physical characteristics demand certain maximum reaction temperatures which cannot be exceeded

2. the immiscibility of most materials which are nitrated with the nitrating agents which are most usually employed makes the question of the rate of the nitrating agent to the reaction-system which the interests of temperature-control demands raises the imperative question of instantaneous dispersion of the nitrating agent upon addition of the same

The heat which is generated during nitration reactions has a double source:- firstly, that emanating from the dilution of the sulphuric acid component of the nitrating agent mixture; and, secondly, that arising from the reaction proper. The measures which must be adopted to assure maximum efficiency with regard to mixing in nitration reactions are similar to those used in the case of sulphonations in dealing with the latter type of reaction's difficulties and demands.-

Acid Treating of Lube Oils:- is a process calling for the treatment of the lube oil fraction of petroleum with sulphuric acid for the purpose of bringing down in the form of a sludge the unwanted unsaturated portions contained in the said fraction. This process may be considered a special instance of the general problem of sulphonation. The process, on a commercial scale, is generally carried out in either of two fashions:

1. batch method---the acid is added to the crude oil fraction in large vats, gradual addition of the acid being employed in the interests of temperature-control. After the full amount of acid required to bring down the unwanted portions in the oil has been added and complete reaction assured, the batch is "rested" and the sludge is allowed to settle as a "foots", the treated oil being decanted thereafter. To assure the thorough distribution of the acid on which the completion of the reaction in a minimum amount of time depends, the measures which must be adopted in view of the relatively high viscosity of the lube oil fraction include:- introduction of the acid at or near the scene of most intense mixing action in the most convenient way in which this may be accomplished; and, employing a mixer which combines a maximum rate of flow-induction with a maximum intensity of direct mechanical action

2. continuous method---in this alternative, the oil fraction and a correctly proportioned amount of acid are continuously fed to one or more mixers (if more than one mixer is employed, these are placed in tandem with one another); the mixed effluent from the mixer/s is then led thru one or more centrifuges, where the sludge is separated from the treated oil. The peculiar demands of the process when operated in this fashion go beyond the requirements of the process when operated in the above fashion. Over and above the measures

which must be adopted for the batch operation, there are the requirements of a continuous mixing operation per se, which will be treated with under a separate heading; and, the requirements in the mixing phase of the operation which affect the continuous operation indulged in afterwards. If the separation of the sludge is to be totally effective, it is utterly necessary that the sludge is not dispersed to colloidal dimensions as it approaches the centrifuge/s. Two measures may be adopted in this regard:-

a. the totally reacted mixture may be brought to a secondary mixing vessel in which an intensity of mixing action prevails which is sufficient to guard against settling of the sludge but yet of a degree which permits the "growth" of the sludge-particles

b. in the second instance, both the promotion of the reaction and the "growing" of the sludge-product may be accomplished within a single vessel. Where this is done, it is accomplished by feeding both the oil to be treated and the treating acid into a piece of mixing equipment which is designed for a maximum of direct mechanical, the promotion of the reaction being accomplished as a function of virtually the milling of one material into another; while the reduced amount of flow-induction of which the mixing unit is capable, because of the special design of the same, is employed as a condition for "growth" of the sludge-particles. In such cases, the mixer is of a highly specialized design so that intimate dispersion is accomplished solely at the mixer's locale proper, the flow-induction component of the mixer's action being purposefully reduced to that minimum required to establish the level of turbulence required for the aforementioned "growth process".

Caustic Refining of Vegetable Oils:- is a process involving the removal of free fatty acids from freshly-extracted vegetable oils in order to improve the edible and storage properties of the oil. Oils may chemically be defined to be compounds of fatty acids with glycerine, more particularly compounds of unsaturated fatty acids with glycerine. However, the freshly-extracted oil will contain free fatty acids in varying degree depending upon the locale from which the speed-base came. These fatty acids are unstable in the presence of air and hence must be removed if the oil is to be protected against turning rancid. This process, like the acid treating of lube oils, may be carried out commercially in either of two ways:-

1. batch method--- caustic soda is introduced into large vats containing oil, the caustic being in water solution and reacting with the free fatty acids to form a soap-curd. Initially the curd is formed to colloidal dimensions and stays suspended in the oil. The temperature of the completely freed oil, at the end of the operation, is raised for the purpose of destroying the colloidal suspension of soap-curd,, for the purpose of coagulating the soap-curd. The coagulated soap-curd is then allowed to settle as a "foots" in the vessel while the processed oil is decanted. The best condition for the successful carrying-out of the process involves:- the most thorough contacting of the caustic solution with the oil batch; and, the use of a minimum excess of the caustic solution. In view of the fact that the normal percentage of free fatty acids in oil is low and, hence, in view of the fact that the amount of caustic solution used is exceptionally small volumetrically in comparison with the volume of oil to be treated, the problem of obtaining complete and uniform contacting of the oil is rather difficult. Complicating the problem of obtaining the required type of dispersion are the following factors:-

a. the caustic solution is immiscible with the oil

b. the greater the amount of time required to obtain the complete reaction of the free fatty acids, the greater is the amount of work spent in continuously sub-dividing the soap-curd which is formed on initial contact with the caustic solution. And the harder does the task of coagulating the soap-curd subsequently become

To assure the most rapid completion of the reaction with the free fatty acids against the retarding influence exerted by the immiscibility of the oil with the caustic solution, the caustic solution should be introduced at the scene of most intense mixing action in the most convenient way in which this may be accomplished. Where propeller mixers are used, the caustic solution should be fed by a pipe into the upstream-side of the propeller as close to the propeller as possible. Where a turbine mixer is employed the pipe-feed line for the caustic solution should be brought in so that the caustic feed is into the hub portion of turbine rotor

2. continuous method---in this method of operation, as proportioned feed of caustic soda and oil is fed to a mixer or mixer tandem continuously, the said mixer or mixer tandem being of the continuous type; the mixer/s effluent is then directed to a heat exchanger, in which the temperature of the stream is raised sufficiently to assure the coagulation of the soap-curd which is produced as a result of the reaction; the stream is thence taken to a centrifuge, in which the coagulated soap-curd is separated from the treated oil. Since the mixer vessels alluded to above are batch type mixing vessels which are adapted to continuous service by providing an overflow nozzle and by providing a continuous feed to the vessel, the problem of establishing contact between the reacting materials within a specified minimum length of time is accentuated. This is true because the use of a fixed rate of feed into a vessel having a fixed holding capacity automatically established a "time limit" within which full contacting must take place. This differs from the case of the batch operation where, if the reaction is not completed within a certain expected period of time, it is possible to arbitrarily prolong the mixing operation. Prolonging the "time limit" referred to above can be done only by reducing the rate of feeding to the mixer/s, and, thus, only by reducing the overall capacity of the treating system as a whole. The problem of "sticking" within the confines of a certain "time limit" in a continuous system may be most efficiently met:- by "channeling" the flow of materials in the mixing vessel (i.e. by limiting the extent of random flow); by feeding the to-be-treated oil and the treating caustic solution to the scene of most intense mixing action; by "injecting" both portions of the feed into the channeled flow in such a fashion as to assure, as far as possible, a uniform path of travel for all portions of the feed; and, by using a sufficient number of mixing vessels in tandem so that no portion of the discharge is present for a period of time less than that required for completion of the treating reacti

Continuous Mixing Problems in General:- as dealt with here, are instances in which mixing vessels are adapted to continuous service by providing the same with overflow nozzles and by feeding the vessels continuously, in which case "previously mixed" materials are "flooded" out of the system at the same rate at which the vessel is fed. Continuous Mixers of this type may be used for gas-liquid, liquid-liquid and solid-liquid mixing operations. The main problems which are inherent in such a type

1. preventing "short-circuiting" from the feed-point to the discharging point

2. providing as uniform a pat. of travel for ·ll portions of the stream as is possible, without sacrificing mixing action

3. bringing as uniform an action as is possible to bear on all portions of the throughput stream

Wherever the type of mixer employed is adapted to the use of draft-tubes in connection therewith, draft-tubes will be found to serve each of the requirements set forth above, in some measure. Requirement #3 given above, while seeming at first to be completely identical with Requirement #2, is in fact synonomous with the latter only to a limited extent. Requirement #2 is achieved either by extending the highly "idirectionalized" flow which is induced by certain types of mixers, such as the propeller and turbine types of mixers; or, by imparting significant amounts of "directionalization" to the flow induced by mixers of the "random-flow" type. This is usually accomplished by the use of draft-tubes. Where the components of the mixture are fed into the draft- tube, Requirement #2 is satisfied to the extent that at least for the immediate period following the introduction of new materials (the initial path of travel) all protions of the charge follow a roughly identical pattern. In a limited way, Requirement #2 continues to be satisfied to the extent that it is impossible for material in the vessel to cycle through the mixing equipment proper without traveling a fairly uniform path from the exit of the draft-tube to the entrance of the draft-tube. In the above-mentioned ways, Requirement #3 as well is served, in a sense. The point at which satisfaction of both Requirements #s 2 & 3, solely by the means stated above, diverges to the greatest extent is the following. Since there exists no process of selection, in continuous mixing equipment of the given type, as to what portions of the vessel charge are to be overflowed and what portions are to stay behind, some of the material which is fed to the equipment is present for the shortest possible stay of time, while other portions may be present for an infinitely long period of time. This is equivalent to saying that while some portions of the fed-stream are subjected to the mixer's actions for a very short period of time, other portions are subjected quantitatively to a much larger amount of work in consequence of their longer stay in the equipment. Where the subjection of all portions of the fed-stream to certain minimym amounts of work is absolutely vital to the achievment of the goal of the mixing action, such differences in the uniformity of actions to which the fed-stream is subjected may be evened out, and even eradicated for all practical purposes, by increasing the number of mixing vessels through which the feed passes. Complete freedom from "short-circuiting" of newly-fed materials, Requirement #1, may be attained by the use of a properly designed draft-tube in connection with the mixing equipment and by feeding the new materials into the draft-tube, preferably as close as possible to the upstream side of the mixing rotors proper.

-.-.-.-.-.-.-.-.-.-.-.-.-.-.-

It should be noted that the above were offered as the most frequently met of special liquid-liquid problems. This must not be taken to mean that there are not numerous isolated examples of liquid-liquid mixing problems which present similar types of difficulties to those set forth above under the various headings. It will be found however that in most cases the difficulties and peculiar aspects of such isolated problems may be related by analogy to those described above, and, hence, are susceptible to the conter-measures employed as per above.

SOME SPECIAL SOLID-LIQUID MIXING PROBLEMS

The overwhelming majority of solid-liquid mixing problems, like the overwhelming majority of liquid-liquid mixing problems, are capable of being handled by normal and standard types of mixing equipment. As regards the relative efficiencies with which the various types of marketed mixing devices of the standard types carry out certain specific tasks, it may be said that in most tasks of a straightforward nature the efficiency attained with any specific piece of mixing equipment is a measure of the extent to which the equipment has been carefully selected from among the various types of standard mixers and is a measure of the care which has been employed in giving the unit its optimum operational characteristi for the job at hand. Standard mixers of virtually the same basic types do differ in their qualitative design and engineering characteristics, though in most cases it will be found that while some of the standard mixers are better engineered than other the results obtained from a functional standpoint are pretty much the same. Design and engineering advantages which some enjoy over others more often than not express themselves in the trouble-free life which they yield in service.

The following widespread specific and general solid-liquid mixing problems are, however, tasks which cannot be carried out with as much efficiency as can reasonably be expected by normal, standard mixing equipment. In the main, these tasks require an accentuation of the direct mechanical action component afforded by the various types of standard mixers.

Cutting or Dissolving of Gums, Plastics, Cellulose Nitrate, Cellulose Acetate, and Rubber:- The dissolving (cutting) of the aforementioned materials, and the materials themselves, have certain characteristics in common. The common characteristic of the dissolving of each is the tendency of the solid to take on a jelly-like consistency on infiltration of the solvents with which they are cut. The common characteristic of the materials themselves is the fact that each is a polymer material of tremendous molecular weight. Two factors determine the extent to which the "jellying" complication can and must be met by countermeasures:- the mean size of the chunks or particles of solid prior to addition to the solvent phase; and, the manner in which addition of the solid phase to the solvent phase is performed. As regards the mean chunk or particle size of the solid on addition, one of three conditions can obtain:- the added solids may be in so fine a form as to reduce the importance of the direct mechanical action component of a mixer; the solids may have a particle-size such as to make the exertion of a direct mechanical action on the solids-charge mandatory for a maximum solution rate; the size of the added solids-particles may be such as to preclude the conveying of thechunks by the liquid streams induced by the agitator mechanism or such as to preclude their passage through the members of a mixing assembly modifie for amplifying its direct mechanical action component. If the first of the aforementioned conditions obtains, then a maximum rate of solution will demand the most extreme condition of turbulence and the choice of mixing equipment as well as the assignment to the chosen mixer of certai operational characteristics will of necessity have to be tuned to the said demand. If the second of the aforementioned conditions obtains, then the setting-up of a maximum rate of solution will depend upon the employment of a mixer exerting a maximum of direct mechanical action. If the third of the aforementioned conditions obtains, the establishmen of a maximum solution velocity will depend not only upon the setting-up a condition of maximum turbulence by the agitator equipment but upon t

existence of a "directionalized" flow of the solvent directed at the sol which would in the given instance tend to either float or settle--depen ing upon the specific gravity of the solids-charge. As regards the que of the fashion in which the addition of the solids is carried out, two basic procedures may be employed:- firstly, the entire charge of solid to be dissolved may be "dumped" at once into the solvent; or, a progres rate of addition of the solids may obtain. If the charge is added as a "dump-charge" and if the solids-charge is added in a finely divided for in any form of division below that described in third condition of part size set forth above, the importance of exerting the maximum of direct mechanical action which is consistent with a high degree of turbulence becomes pronounced. If the charge is added as a "dump-charge" and is i a state of d vision as described under the third condition set forth ab the importance of both "directionalization" of solvent flow and of the use of a most extreme condition of turbulence becomes all the more acce uated. If the charge is added to the solvent phase progressively--- preferably so that the amount of undissolved material present in the solvent at any time during the dissol ing operation is tuned to the bes conditions for the mixer's operation, the result for either of the firs two named conditions of solids-division is to reduce the critical natur of the specific types of mixer action recommended in each case above and to promote an increased over-all solution velocity. The two other factors which enter into operations of the above sort and which deserve attention is the following:- the extent to which the saturation limit of the solvent is approached; and, the maximum v scosity which the solut will assume prior to completion of the dissolving operation. Regarding the influence of the extent to which the saturation limit of a solvent approached, it may well be stated that the closer the said limit is approached the more critical does it become to furnish the types of act recommended above under the various categories of addit on procedure a particle-size in the solids-charge. As regards the in luence of the viscosity assumed during the final stages of a dissolving operation, it should be noted that, where the said viscosity goes outside the range within which high speed mixers may be profitably and efficiently emplo and where the initial viscosity of the mixture would permit the use of high speed mixing equipment, on-of two measures may be adopted to meet the situation:- either a double-motion agitator assembly may be used, each motion being separately powered for individual and separate use of either motion; or, themixing equipment may be selected with an eye to efficiently carrying out the last and most critical stage of the disso ing operation while permitting an inefficient operation for the initial stages of the dissolving operation. The double-motion agitator permits the use of a high speed mixer as one member of the combination for the initial stages of the dissolving operation and a slow speed member for hig v scosity stages. Frequently the above-difficulties which attend progressive increase of viscosity of solution and the approach of solvent's saturation limit may be avoided by using a large excess of solvent for the dissolving operation until complete dissolving of the particular solid has been attained, the excess being evaporated off lat and recovered. The foregoing remarks will be found to a ply to the dissolving of lignin as well. It should be noted that in referring to resins and gums in the heading to this section only those gums which are alled in the solid or extremely heavy paste consistency are meant.

Dissolving of Certain "Non-Jellying" Solids: Certain instances of dissolving operations involving "non-jellying" solids are critical. (DEFINITION:- "Jellying" materials include those solids and extraordinarily high consistency states which, on contact with a solvent, tend to absorb solvent all over their contact area with the solvent phase and which as a result of the said solvent-infiltration take on a markedly different consistency at their peripheries than characterizes their cores---the said peripheral zone of differing consistency being in the nature of a closely adhering jelly). Whether the dissolving of materials coming under the heading of "non-jellying" substances is of critical nature or not depends upon:- the state of division of the solid charge upon introduction; the basic solution velocity constant for the operation at hand; and the extent to which the proposed solids-charge approaches the saturation limit for the solvent at hand. Grossly classified from the standpoint of mixing operations, a solids-charge if uniform as to size, may be in either of three groups:- the solids may be in so fine a state of division as to nullify the direct mechanical action which any particular used type of mixer is capable of exerting; the solids may be of such particle-size as to permit the effective use of a mixer's direct mechanical action component; or, the pieces of the charge may be of such large size as to preclude the conveying of the said pieces by the various induced streams of flow. The aforementioned categories are named in their progressing order with respect to particle-size. The following types of "non-jellying" materials dissolving operations are critical ones which may be accelerated from the standpoint of overall velocity mechanical action:-

1. instances in which materials belonging to the second-named category of division are being dissolved in solvents in which the given solid is characterized by a low to medium solution velocity constant

2. instances in which solids belonging to the second-named category of division are being dissolved in a liquid to an extent approaching closely, equalling (saturated solutions), or exceeding (supersaturated solutions) the saturation limit of the solvent at hand

3. and especially in instances combining the characteristics of the two above-given examples

Materials belonging to the third named category of division do, especially when the contemplated solutions approach the saturated state and/or where low to medium solution velocity constants characterize the solution, lend heavily upon providing "directional gel" flow and high degrees of turbulence. This aforementioned type of mixing problem may also be considered to be of a critical type. The distinction between "jellying" and "non-jellying" materials, with respect to the dissolving of the same, is a valid one to the extent that while agglomeration of "jellying" materials after contact with a solvent phase is a problem to be contended with in the dissolving of "jellying" materials, it is not significantly present as a factor in the dissolving of "non-jellying" materials. For the aforementioned reason the manner of addition of the solids-charge, where "non-jellying" materials are concerned, is not an important factor.

Agitation of "Tender" Solids:- Critical solid-liquid mixing problems . sometimes involved in the agitation of fibrous or gelatinous materials in the agitation of crystal suspensions, in the dissolving and suspen of organic materials having tremendous molecular weights. Such critical problems frequently take the form of requiring agitation while at the sa time precluding any appreciable direct mechanical action on the solids-charge. Instances of this sort may at times be presented by:-

1. the agitation of paper in stock chests

2. problems calling for the distribution of large particle-size solid catalysts

3. mixing problems in which the preparation or treatment of wate treating gels is involved

4. cases where mixing is an auxiliary condition in the precipitat or "striking" of pigments, color lakes, etc.

5. cases where alumina hydrate and similar surface-active materi are formed or treated

6. problems where extractions of oils present in vegetable seeds, etc. are being pursued

The above-mentioned instances are, of course, but a few examples, selec because of their rather widespread usage, of a category of mixing probl which includes numerous more isolated but completely analagous cases. The problem of accomplishing agitation or achieving a distribution unde conditions which demand a zero or near-zero application of direct mechan action is most usually met by using slow speed mixers, of the type whic include the paddle, horseshoe, gate, etc. mexers. The more serious the necessity for avoiding direct mechanical action on the solids-charge, th nearer to theminimum allowable speed for the specific type of mixer use would the speed assigned to any given mixer be. Naturally, in order to satisfy the demands of uniform distribution of mixing action, the slow the speed assigned to the mixer used, the greater would the number of me of which the mixer would be composed be and/or the greater would the op area of the mixer be.

-.-

Other solid-liquid mixing problems of a special type, such as those of agitating crystallization systems and preparing suspensions, which migh be discussed under this heading have been given a rather complete discu in the Questions and Answers Section of the Manual. Much of the materi given above under the heading of the dissolving of "non-jellying" materi when taken in conjunction with the remarks given in the Questions and Answers Section on the subject of suspensions give an adequate treatmen of the special aspects which attend the formation of certain suspensions. The material given above on the agitation of "tender" materials taken i conjunction with the remarks given in the Questions and Answers Section the question of conditioning crystallizations yields a proper insight into such special crystallization problems as may arise

INSTRUCTION SHEET FOR SELECTING GAS-LIQUID MIXERS

Gas-liquid mixers may be one of the following types:-

1. those in which gas is fed to the mixing equipment under exter established flow potentials

2. those in which gas is "fed" to the mixing equipment in consequ of the mixer's acting as a "wet" fan

3. those in which both means of bringing the gas to the mixing equipment described above is used

Gas-liquid mixers involving externally established flow potentials:-

1. the means of externally establishing the flow potential may comprise a fan, compressor, pressure storage cylinder, etc.

2. the method for determining the probable effect of a mixer ele in a gas-liquid mixer includes the following steps. where the liquid is of any consistency other than paste or plastic:-

   a. substitute the proper figures for the following symbo

      $$(Qhd)/33,000$$

      where Q is the number of cu. ft. of gas being intro- duced per min. at the back-pressure conditions existi in the mixing vessel; where h is the number of feet liquid of vertical height thru which the gas must ri in escaping from the liquid into which it is introduc and, where d is the density of the liquid in terms o lbs. per cu. ft.

   b. select from Chart #1 that value which corresponds to t volume of liquid being handled and to the consistenc range for the liquid at hand.

   c. divide the value obtained as per (a) above by that obtained under (b) and the quotient so obtained will have the following significances:-

      A. if the quotient obtained is in the vicinity of 0.5 or if it is greater, the probable improvem in performance which may be expected for a mechanical means of agitation over simply allo the gas to bubble thru by itself will be insi icant or nearly-insignificant. In such a case do not recommend the use of any of our Gas-liq Mixing Equipment

      B. if the quotient obtained above is greater tha 0.1 but smaller than 0.5, use a Gas Liquid Mixer of the GA type

C. if the quotient obtained is less than 0.1, use a Gas-Liquid mixer of the GV type, if a of minimum cost is required

d. if, according to (c), either a mixer of the GA or G type should be employed, the diameter of mixer used should be selected in accordance with the rules gov ing the selection of proper diameter turbine mixers but the powering of the mixers should be in accorda with the horsepower levels laid down in Chart #1. choose the proper speed for such a mixer unit as ty GA or GB, proceed as follows:-

A. divide the horsepower value required by Char #1 by the appropriate viscosity factor given under the Turbine Mixer Design Instructions

B. using the Turbine Mixer Power Chart for Wate Viscosity, seek the point at which the value yielded by (A) intersects the properly chose turbine-diameter line and nominate the speed which corresponds to the intersection-point as the proper speed to be used. This speed should be used unless:- for turbines of 9" diameter or smaller, it involves speeds in ex of 1800 ft. per min.; for turbines up to and including 30" diameter turbine, it involves of 1200 ft. per min. or more; for turbines o greater than 30", it involves speeds of 1,00 ft. per min. or more. In the latter instanc a multi-turbine assembly involving the small number of rotors whosecombined power consump will equal the value yielded by (A) when lim to the above-given speed ranges should be us To properly distribute a number of turbines o a shaft use the rule:- that the height of li above the top turbine and below the bottom turbine should equal the total liquid height divided by twice the number of turbines used while the distance between any two turbines should be equal to twice the aforementioned

EXAMPLE:-

Select a gas-liquid mixer to distribute, at a maximum, 50 cu. ft. of g per min., referred to the gas-distributionpoint, into a 1,000 gals. wo capacity vessel. The liquid has a viscosity of 500 centipoises. The is to feed into vessel under from a pressure storage cylinder. The ve has a liquid depth of 8 ft. and a diameter of 54". The gas is to be fe into the liquid at any optimum depth in the tank. The specific gravit of the liquid is 1.4.

Solution:-

If the specific gravity of the liquid is 1.4 and the density of water #1 cu. ft., then the density of the fluid in question is:-

$$(62.5)\ (1.4) = 82.5\ \#1 \text{ cu. ft.} \qquad (1)$$

If we assume that at a maximum the point of gas distribution would be a distance off the bottom of the mixing vessel equal to 25% the liquid height, or (0.25)(8) = 2 ft., then

$$\frac{Qhd}{33{,}000} = \frac{(50)(\ )(82.5)}{33{,}000} = \frac{14{,}860}{33{,}000} = 0.45 = \text{horsepower}$$

From Chart #1, we see that for a viscosity of 500 centipoises (i.e. gr than a "thin" consistency) and a working volume of 1,000 gals., the po required would be 3 horsepower. The ratio of air-horsepower expended required mechanical agitation for the given volume, if a condition of optimum gas dispersion is to be achieved, is

$$\frac{0.45}{3.0} = 0.15 \qquad (3)$$

And hence a Type GA Gas-Liquid Mixer should be used.
Referring to the Turbine Mixer Design Instructions, it will be seen th the diameter of mixing unit which should be used is a

$$\frac{54}{4} = 13\text{"} \qquad (4)$$

or a 15" diameter unit as the next standard size, since the diameter o vessel is 54" and the consistency of the material such as to make the of a rotor diameter-to-kettle diameter of 1:4 a feasible one. If 3H.P. (Equation 3) is required to achieve an optimum agitational condition fo the gas-liquid mixing operation at hand and if the viscosity correction factor (NOTE: See Turbine Mixer Design Instructions) for a 500 centipo consisting is approximately 1.18, then the "water-equivalent horsepower would be

$$\frac{3.00}{1.18} = 2.54 \text{ horsepower} \qquad (5)$$

This would correspond to a turbine speed NOTE: See Turbine Mixer Power Chart) of 1075 ft. per min. This mixer should be placed as far down i the vessel as possible.

EXAMPLE:-

Select a gas-liquid mixer to distribute 100 cu.ft. per min. of a gas, referred to the gas-distribution point, in a 2,000 gals. working capac vessel. The liquid has a viscosity of 100 centipoises. The gas is t be fed from a compressor. The vessel has a liquid depth of 9 ft. and a diameter of 72". The gas is to be fed into the vessel at a point 1 ft off the deepest point in the tank. The specific gravity of the liquid phase is 0.9.

Solution:-

The density of the liquid at hand is

$$(0.9)(62.5) = 56.25 \text{ lb. } 1 \text{ cu. ft.} \qquad (1)$$

The height of li[redacted]d thru which the ga[redacted]ise would be

$$(9 - 1) = 8'$$

and hence the air-horsepower expended in bubbling thru the liquid would

$$\frac{(8)\ (100)\ (56.25)}{33{,}000} = 1.365 \text{ horsepower} \qquad (2)$$

The ratio of air-horsepower expended to the optimum degree of mechanica agitation, for 2000 gals. of liquid of greater than "thin" viscosity. would be(NOTE: See Chart #1)

$$\frac{1.365}{7.5} = 0.18 \qquad (3)$$

A Type GA Gas-Liquid Mixer should then be used. The equivalent "water consistency horsepower" which should be expended in this case would be (NOTE: See "viscosity correction factors" in Turbine Mixer Design Instructions)

$$\frac{7.5}{1.1} = 6.82 \text{ horsepower}$$

The diameter of turbine/s which should be used is

$$\frac{72}{4} = 18" \qquad (4)$$

and the turbine speed which would correspond to 6.82 horsepower would b 1520 ft. per min., if one turbine unit were employed. Using the limiti speed of 1200 ft. per min. for turbines of greater than 9" in diameter, it will be noted that, since the power consumed by an 18" turbine would approximately 3.8 horsepower at 1200 ft. per min., then

$$\frac{6.82}{3.8} = 1\not$$ (illegible) $\qquad (5)$

or 2 turbines should be used, each consuming

$$\frac{6.82}{2} = 3.41 \text{ horsepower} \qquad (6)$$

The assembly would then (NOTE: See the Turbine Mixer Power Chart) requ 2-18" diameter mixers running at 1140 ft. permin. Since the total liqui height is 9', the distance of the lower turbine off the bottom of the vessel would have to be

$$\frac{9}{(2)(2)} = 2\tfrac{1}{4}' \qquad (7)$$

while the distance between the two rotors would be

$$)2)\ (2\tfrac{1}{4}) = 4\tfrac{1}{2}' \qquad (8)$$

The gas-distribution may be accomplished at the lower wheel in total since the ratio of air-horsepower involved in so doing to the mechanical agitation provided by the lower motor alone is less than 0.6 or. the gas be distributed by two identical type GA units, each assuming half of the gas-introduction load. Since the distribution of the gas in total at the lower wheel is possible and since:-

1) distribution at the lower wheel involves a longer gas-pots of rise in escaping from the liquid

2) the use of one GA mixer and one NT mixer (i.e. the NT mixer acting in auxiliary fashion in exerting an agitational effect upon the gas-injected charge emitted by the GA Mixer) would be a more economical assembly.

the latter type of multi-turbine assembly is selected.

Gas-Liquid Mixer Involving A "Wet Fan" Action:-

1. A gas-liquid mixer, such as Type GC, develops a "wet" fan action in consequence of the following effects:-

   a. the suction developed by the turbine directly
   b. the inducing of a high velocity flow outside the concentrically-placed tube

Item (a) is directly analogous to the suctionwhich may be developed at the inlet of a centrifugal pump. Item (b) may be explained by the s given below:-

In the given sketch. two identical open-top tubes having 90° bends at their bottom ends are inserted vertically into a pipe in which a flow liquid is taking place, onewhere the pipe has a diameter of d, and the other where the pipe has a diameter of d_2. The differences in velocit at both points will be reflected by the difference in heights (Δh) to which the liquid rises in the given tubes. When the flow of liquid go in the direction indicated above, the height of liquid in Tube A will exceed that in Tube B; while when flow takes place in the opposite direction the reverse would be true.

The difference in heights in either case would be exactly equal and wo be equal to

$$\left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right) \qquad (1)$$

SAC

June 25, 1963

SA T. SCOTT MILLER, JR.

HARRY GOLD, W.B.,
ESPIONAGE - R

Exhibit 65-1201-H-12 (3) - envelope

MANILA ENVELOPE FOUND IN SAFE FOR
IN EAST WING OF DALAS OFFICE

The above exhibit was given to [illegible] on June 24, 1963, and consists of a manila envelope with the following written on the [illegible] in red pencil: Enclosed is sheet showing where space has been left for turning-overs on the original copy - Attention Mr. Brotherman." GOLD stated that this was not his handwriting on the outside of the envelope and is not that of anyone he knows, but that it probably is a stenographer's.

GOLD stated that this one typewritten page, which is numbered 52 at the top, is concerned with mixing equipment and belongs with Exhibit H-12 (3) - Folder 11.

GOLD stated that this was probably given to him by [illegible] at the same time that the material mentioned in Folder #11 was given him.

MT:ac
65-130.

assuming that no pressure drop takes place between thepoints of insert. of the tubes because of frictional impedance to flow, and that the pip horizontal so that no change instatic head exists between said points where V_1 in ft. per sec. is the velocity of flow at that portion of t pipe whose diameter is d_1, and V_2 the velocity of flow in ft. per sec. where the pipe is of d_2 diameter.

For the case of either of the tubes shown in the sketch and for the direction of liquid flow indicated, the height of rise in the tube is given by the relationship

(static head / pressure head - velocity head) (2)

If the velocity head is established at a sufficiently high level (i.e. by setting the velocity of flow sufficiently high), the tube may be emp of all liquid - and furter, a suction of gas into the liquid stream (an aspirator - or inspirator effect) will be developed. In the case of th Type GC mixer (NOTE: See sketch below),

the direct suction-action of the turbine partially lowers the level of liquid in the concentric tube but the main burden of the task of emptyi the concentric tube and developing the gas-suction if accomplished by t extablishing of a maximum velocity head for the liquid passing thru the external tube and past the concentric tube. In the case of the Type GC mixer and as regards Equation (2), the height of rise of liquid in the concentric tube - or the extent of the gas-suction developed - will in this case be given by the expression

(static head - velocity head)

To keep the gas-suction at a maximum the static head of liq id above th mixing unit is kept at a minimum - is rarely allowed to exceed 6".

2. the method of selecting a "wet" fan gas-liquid mixer consist of the following steps:-

a. substitute the proper valves in the expression

$$\frac{(Q)(h)(d)}{(33{,}000)(0.25)} = \text{fan mechanical horsepower requirement}$$

where Q is the volume of gas to be induced in cu. ft. per min., when h is the static head of liquid above th centerline of themixer rotor - andnormally equal to 6" and where d is the density of the liquid phase in lbs. per cu. ft.

SAC 6/27/50

SA T. SCOTT MILLER, JR.

HARRY GOLD, WAS.
ESPIONAGE - R

65-4307-1-B-12 (4) - Folder #7

MATERIAL FOUND IN A WOODEN BOX IN THE BASEMENT OF GOLD'S HOME

The above exhibit was shown to GOLD on 6/24/50 and consists of a manila folder entitled "2. A.S.M.E. Specifications". Contained in this folder are three 8" x 11" pieces of white paper, #26, #27, and #28, with typewriting on each page.

GOLD stated that this material had been given to him by BROTHMAN for delivery to the Soviets and this material was concerned with mixing material.

GOLD stated that the material had not been handed over to the Soviets for reasons he had previously stated in connection with information on the mixing material.

tsm/rac
65-4307

(American Society of Mechanical Engineers and/or the American Petroleum Institute-American Society of Mechanical Engineers Codes for Unfired Pressure Vessels)

The above-mentioned Codes govern the design and fabrication of vessels operating under pressure. These Codes specify the minimum thicknesses of plate which may be employed for any pressure-stressed portion of a vessel coming under its rulings, the types of welds which may be used to join pressure-stressed members in a vessel, the methods and types of reinforcement which may be used to back-up pressure-stressed members in a vessel, the procedures which are to be employed in welding, and the tests which are to be applied to the completely fabricated vessel.

The Codes are mandatory in the states of New Jersey, Ohio, and Pennsylvania; all vessels installed in these states must be fabricated and stamped as Code vessels, if the said vessels come within the Codes' definitions of a pressure vessel. In all other states, at the present writing, Code fabrication is optional with the Purchaser of the Fabricat

The Codes definition of a pressure vessel, as far as the applications of the Codes' rulings, are concerned to be any vessel:-

1. in which

   $(P-15)(D-4) = 60$, or a value greater than 60

2. and, in which

   $(P-15)(V-1.5) = 22.5$, or a value greater than 22.5

where P is the internal and, the jacket pressure of a vessel at hand, in terms of lbs. per sq. in., where D is the diameter of the cylinder portion of the pressure stressed container in inches, where V is the volume of the vessel and/or its jacket in cu.ft. If the vessel is jacketed and the interiro chamber is open to the atmosphere, V must be taken as the volume of the jacket itself; whereas if the vessel in question is jacketed and if the contents of the internal chamber is closed to the atmosphere, V is the combined volume of the jacket and the internal chamber and P must be taken, in the second equation, as the greater of either the jacket or the internal chamber press

Pressure vessels, so defined, are construction under one or more of the following Paragraphs or classifications of the Codes:-

1. Paregraph U-70 (Class 3 or C):- for vessels operating under less than 200 psi of internal or jacket pressure containing gases at temperatures not exceeding 250°F. and/or liquids at temperatures below their normal boiling points and not at temperatures exceeding 250° F. These gases or liquids may not, however, be of a lethal nature.

2. Paragraph U-69 (Class 2 or B):- for vessels operating under less than 400 psi of internal or jacket pressure containing gases at temperatures not exceeding 700° F. and/or liquids at temperatures not exceeding 300° F. The contained gases and/or liquids may not, under this construction, be of a lethal nature

3. Paragraph U-68 (Class 1 or A):- for vessels operating at jacket or internal pressures up to 400 psi or more containing gases at temperature in excess of or at 700° F. and/or liquids at temperatures exceeding

300° F. [redacted] pressure vessels containing [redacted]nal gases and/or liquids must be designed and fabricated under this section of the Codes.

In specifying above that all pressure vessels to which the Codes apply may be welded under one or more of the above-indicated classifications, reference is made to the fact that where an internal chamber may frequently come within the requirements of a higher classification of the Code and its jacket within a lower classification each may be fabricated in accordance with that section of the Code which applies to it. In most instances, however, the vessel as a whole is fabricated under one section of the Codes.

Some of the more important fabrication and testing procedures specified by the various classifications cited above are:-

1. Paragraph U-70:-

   a. U-70 procedures may not be applied to vessels requiring plate, in the head or drum portions of the vessel, in excess of 5/8"

   b. depending upon the thicknesses of plate joined, welds of the double-lap, single-butt, or double-butt types may be used for the plate portions of the vessel

   c. the efficiency assumed for the weld in designing depends upon the type of weld used byt may in no case be as great as 80%

   d. test procedures include:- a hydrostatic test at 1.5 times the rated pressure for the vessel; and, an impact hammer test

2. Paragraph U-69:-

   a. all welds joining the plate portions of a vessel under this classification may only be of the single-butt or double-butt type, whether one or the other is used depending upon the thicknesses of plate involved

   b. the maximum efficiency for a weld under this classification which may be assumed for design purposes is 80%

   c. vessels coming under this classification and involving 1-1/4" or thicker plates in either the head or the drum portions of the vessel must be subjected to stress-relieving operations

   d. test procedures for vessels coming under this classification include:- a hydrostatic test at 1.5 times the rated working pressure; and, an impact hammer test

3. Paragraph U-68:-

   a. regardless of the thicknesses of plate involved, all plate portions of a vessel coming under this heading must be joined by welds of the double-butt type

   b. welds joining the plate portions of such vessels may be designed on the basis of a 90% efficiency

   c. all vessels fabricated under this headingmust be subjected to stress-relieving operations

d. the test procedures for vessels under this heading include:- an impact hammer test; x-ray examination of all welded seams; and, a hydrostatic test at 1.5 times the rated working pressure for the vessel. Vessels furnished under that heading must be accompanied at the time of completion of the job with test-plates made by the welder who worked on the job

NOTES:-

1. the efficiency of a weld is taken to mean the ratio of the strength of the weld to that of the parent metals which it joins. The officiencies taken by the Codes assume the strength of the weld to be less than that of the parent metals though this is in actuality only infrequently the case

2. where pressures are referred to above, it makes no difference as to whether gasm hydraulic, or vapor pressures are concerned

3. stress-relieving for carbon steel plate involves raising the welded vessel itself as a whole to a temperature between 1100° F. and 1200° F. and holding at the said temperature interval for a period of time equal to one hour per inch of plate thickness involved at a maximum (i.e. based on the maximum plate course involved in the said vessel). The vessel is then cooled in a still atmosphere. Under special conditions, carbon steel vessels may be stress relieved at temperature ranges slightly below those named, providing adjustments in the period of heat maintainance per inch of maximum plate thickness are made to compensate for the lower stress-relieving temperatures used. Alloy metal vessels are annealed at other temperatures than those stated above, in most instances, and may frequently involve cooling by quenching in oils or water.

SAC

June 2[illegible], 1950

SA T. SCOTT MILLER, JR.

HARRY GOLD, was.,
ESPIONAGE - R

Exhibit 65-4307-1B-12 (4) - Folder #1

MATERIAL FOUND IN WOODEN BOX
IN BASEMENT OF GOLD'S HOME

The above exhibit was shown to GOLD on June 22, 1950. This exhibit consists of thirty-one (31) pages of handwritten notes entitled "Hendrick Continuous Method for Buna-S Manufacture," and the original and one carbon copy of a two-page typewritten document entitled "Notes on Continuous Method Report."

GOLD stated that all of the handwritten material was in BROTHMAN's handwriting. He said that this data was submitted to GOLD by BROTHMAN prior to the end of March 1942 when BROTHMAN gave GOLD the complete Buna-S report. GOLD said that this is an extremely complete and detailed report and indicates the quality of the work, which was later turned over to SAM by GOLD in the form of a typewritten and more complete report.

GOLD stated that the reason this handwritten report is still in his possession is that the handwritten report is supplanted by the typewritten report.

GOLD stated that he noticed some of the pages of the handwritten report had been cut. He stated that those referred to corrections the writer of the report made.

On the outside of the folder appears the notation in GOLD's handwriting in red pencil, "Lt. [illegible]AN, Naval Procurement Department, Miller Building, [illegible]ORKLAC, Boss." GOLD said that he could only guess as to what the notation on the outside of this folder meant and he would guess that the names had been given to him by CARTER HODGELESS shortly after GOLD had been turned down for the draft because of physical disability, (early 1942). HODGELESS thought he might be able to get him the above the names for GOLD to contact relative to possibly getting into the Service and placed where his physical disability would not interfere. GOLD said that he never did anything about it as far as he could recall.

TDM:as
65-4307

All the material contained in this envelope was introduced in to evidence by the government at Brothman's trial and is being maintained by USN. Dept